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D R A F T:

ENVIRONMENTAL IMPACT STATEMENT
FOR THE PROPOSED EXPANSION OF THE
HOERNER-WALDORF PULP AND PAPER MILL
AT MISSOULA, MONTANA

June 17, 1974

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Draft Environmental Impact Statement
for Expansion of the Hoerner-Waldorf Pulp & Paper Mill
at Missoula, Montana

ERRATA

AIR QUALITY

Page 8

Under Pulp Making #1 should have been 275 tons of pulp instead of 340.

Page 15

Figure 1 should have been modified to include the following:

Particulate emissions from auxiliary boilers - 800 #/day

TRS emissions from lime kilns-145 #/day

TRS emissions from concentrators and evaporators - 451 #/day

These data are for the expansion as proposed.

Page 16, Line 21

The soda losses given are total soda losses. Of the 60 # total, approximately 30 #/TADP are lost in the pulp and 30 #/TADP in the water.

Page 17

The data regarding percent solids in the various liquor streams are slightly different for H-W than reported. The values should be for the evaporation 40-45% instead of 50-55% and for the concentrators 60-62% instead of 64-66%.

Page 22, Line 20-22

The sentences should read . . . concentrator vent to the non-condensable system. With the proposed expansion the additional concentrator gases. . . .

Page 23, Line 1

The proper units are pounds per 10⁶ gallons not milligrams/liter.

Page 23, Line 19

At current production levels TRS emission from the recoverys are 135 #/day. The 172 #/day number would result if #4 were operated at capacity.

Page 23, Line 22

The correct particulate emission is 1890 #/day for the same reasons as above.

Page 23, Line 25

H-W is presently operating the furnaces to limit SO₂ emissions to 5000 #/day not 6490.

Page 24, Lines 9 and 11

The respective TRS emission data should be 234 #/day instead of 219 and 145 #/day instead of 353. The reduction with the expansion will be the result of caustic addition to the scrubber water.

Tables 2, 3 and 4 have been corrected as follows:

Table 2 last line 5000 #/day instead 1500

Table 3

FUTURE MILL, NO EXPANSION

Source	Pollutant	TRS	SO ₂	PART.
#2 recovery boiler		0	1250	0
#3 recovery boiler		55	to	1000
#4 recovery boiler		80	5000	890
Brown stock washers		91	0	984
#1 lime kiln		62	0	90
#2 lime kiln		62	0	250
#3 lime kiln		110	0	180
#4 lime kiln		0	0	0
#1 and 2 slakers		0	0	65
#3 slakers		0	0	65
#4 slakers		0	0	0
#2 smelt dissolving tanks		0	0	0
#3 smelt dissolving tanks		2.3	0	870
#4 smelt dissolving tanks		2.4	0	290

Table 3 (Cont.)			
Source	Pollutant	TRS	SO ₂ PART.
Foul condensate streams		2805	0 0
Ponds		404	0 0
Tall Oil Reactor		1	0 0
Existing wood boiler		0	0 200
New wood boiler		0	0 0
#1 recover - power			
Existing Power			
Raw materials conveying system			445
Miscellaneous odor sources		18.5	0 0
		3693	1250 to 5000 5329

Table 4

The upper limit of SO₂ emissions should be 5000 #/day not 7950 #/day.

Also particulate emissions from the wood-fired boiler should have been listed as 600 #/day.

Page 37

The chemical amounts listed in Table 5 for the 1977 unexpanded mill were not calculated correctly. A safe estimate is that chemical usage would not change significantly from current values.

Table 5

HOERNER-WALDORF CORPORATION, MISSOULA
MONTHLY WOOD, CHEMICAL, AND ENERGY USAGE

Material	Units	1973	1977	1977
			No Expansion	Expanded Mill
Chips	Dry Tons	69,452	69,452	78,700
Sawduat	Dry Tons	2,432	2,432	17,700
Hogged Fuel	Wet Tons	7,840	7,840	19,000
Salt Cake	Tons	1,875	1,375	810
Caustic Soda	Tons	1,044	1,044	1,934
Spent Caustic	Tons	46	46	81
Lime	Tons	275	275	460
Chlorine	Tons	380	380	59
Sodium Chlorate	Tons	27	27	4
Sulfur Dioxide	Tons	15	15	4
Sulfuric Acid	Tons	563	563	703
Alum	Tons	449	449	730
Starch	Tons	608	608	669
Gum	Tons	32	32	97
Bulk Rosin	Tons	4	4	56
Natural Gas	MCF	388,000	388,000*	564,000
Fuel Oil	Gallons	92,000	92,000*	150,000
Purchased Electrical		12,830	20,140*	34,200
Power	Thousand KWH			

*Subject to changes due to supplies, prices, markets.

Page 63

Add at bottom: Hoerner-Waldorf has recently informed the Air Quality Bureau that the flow problem at the Hill station was corrected about the first of May. Readings taken since that time should better indicate ambient sulfur dioxide at that location.

Page 67, Table 13

The parenthetic number for Feb.--high for month should be (1). There was only one reading exceeding 12 ug/m³. There was one of 12.0 ug/m³.

Page 118

The table included was an early submittal and is no longer valid. The proper table is presented as follows:

7.0 COSTS OF AIR POLLUTION CONTROL FACILITIES

7.1	Black liquor concentrator and building	\$ 406,000
7.2	Non-condensable gas collection and incineration system for new evaporators and sawdust digester	70,000
7.3	Recovery boiler conversion to controlled odor	2,123,000
	Precipitator including structures	1,958,000
7.4	#2 recovery dissolving tank vent	57,000
7.5	#2 power boiler scrubber and structure	1,117,000
7.6	Lime kiln scrubber	82,000
7.7	Tall oil vent scrubber	25,000
7.8	#3 slaker vent scrubber	29,000
7.9	Second stage cyclone	20,000
7.10	Entrainment separator washer hood vents	25,000
7.11	Condensate stripping system	<u>240,000</u>
	TOTAL DIRECT COST	\$6,152,000
7.12	Premium time	65,000
7.13	Escalation	524,000
7.14	Contingencies	314,000
7.15	Engineering	<u>370,000</u>
	TOTAL	\$7,425,000

Page 142, Line 3, Paragraph B

Change would to could.

WATER QUALITY

Page 3 - 4

The column under New Source Performance Standards from top to bottom should read 6.2, 3.1, 15, 7.5, 30, and 20.

Page 32

Last paragraph - delete "About 90" percent and replace with The majority.

Page 35

Table following nitrate in first column, should read (as NO_3)

Page 35

Table - nitrate (as N) in second column should read nitrite (as NO_2).

Change PO_4 to phosphorous.

Page 40

Third paragraph - Remove parenthesis from "when the river was above 7,000 cfs."

Page 41

First complete paragraph - delete first sentence and replace with:
H-W originally projected a requirement of 325 acres of additional ponds, but this acreage should be greatly reduced with usage of the rapid infiltration.

Page 42

Column under Existing Mill - Phosphorus should read 92 instead of 26.
Nitrogen should read 580 instead of 560.

Page 42

Column under Existing Mill with Biological Treatment and APS - change flow from 21.6 to 15.8.

Page 42

First complete paragraph. Add at end of paragraph: A flow of 21.6 mgd was utilized in calculation of quantities of the other constituents.

Page 85

Under Groundwater - change fourth sentence to read: About 10.0 mgd of effluent percolates through pond bottoms with ponds 14 and 15 and the two experimental rapid infiltration basins accounting for the majority of total percolation.

Page 85

Under Proposed Disposal System - Following first sentence delete remainder of paragraph and replace with: The new system, combined with the old, is expected to have the flexibility of final discharge through seepage, direct discharge controlled by river color, and storage. Dependent on river conditions, various combinations would be utilized.

Page 88

Second complete sentence - Change H-W to Konizeski.

Page 89

Second complete sentence - Change 9.5 mgd or 55% to 11 mgd or 60%.

Page 89

Second sentence in H-W quote - replace evaporation with coagulation.

Page 90

Third sentence - change gaoons to gallons.

Page 91

First paragraph, second sentence, Replace 94 with 100, 20.3 with 21.6, 103 with 112. Third sentence, replace 20.3 with 21.6.

Page 113

Table 30 - heading on second column should be existing disposal system*; 7-day/10-year low flow (930 cfs) is applicable to third and fourth columns; average annual flow (5448 cfs) is applicable to columns 5 and 6; sulfates in second column should read 1.1 instead of 0.50. Phosphorus in second column should read 0.005 instead of 0.0001; Nitrogen in second column should read 0.029 instead of 0.028. Sulfates in fifth column should read 2.00 instead of 2004.

Page 141

Under paragraph shown as 1 - fourth line, change "u" to 7.0 mg/l

Page 142

Delete last paragraph shown as 5.

Page B14

Last paragraph - delete last two sentences.

Page B15

First paragraph - delete "may increase the phosphorous load to the receiving waters, but at the same time it " Also delete last sentence.



Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

John S. Anderson M.D.
DIRECTOR

June 17, 1974

Ladies and Gentlemen:

This environmental impact statement has been prepared in compliance with the Montana Environmental Policy Act. Comments from the public will be accepted for at least 30 days, and a 15-day extension will be granted if requested.

In recognition of the public interest in the proposed project, a public hearing will be held in Missoula no earlier than July 17, 1974. At least three weeks notice will be given prior to the hearing.

Comments and questions regarding the impact statement or the hearing should be directed to Daniel Vichorek, Technical Writer, Environmental Sciences Division, State Department of Health and Environmental Sciences, Helena, Montana 59601.

Sincerely,

Daniel Vichorek
Technical Writer
Environmental Sciences Division

DV:mc

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TABLE OF CONTENTS

Page

Summary

I. Introduction	1
A. Description of the Proposed Action	1
II. Description of Plant and Process	13
A. Basic Manufacturing Process	13
B. Sources and Nature of Pollution	20
C. History of Pollution and Control at Hoerner-Waldorf	27
D. Energy and Raw Material Consumption	37
E. Wastewater Treatment and Control	38
III. Existing Environment	45
A. Air Quality	45
B. Water Quality	85
C. Social and Economic Considerations	116
D. Wood Waste Supply	122
E. Vegetation	128
IV. Actions Available to SDHES	140
A. Statutory Authority	140
V. Environmental Impacts of Actions Available to the Department	141
A. If the Permit Were Denied	141
B. If the Permit were Granted as Requested	142
VI. Conclusion	144
References	145
Glossary	148
Appendix A - Air Quality Regulations	A-1
Appendix B - Water Quality Laws, Regulations, and Compliance Schedules	B-1
Appendix C - Quality Control of Gas Chromatograph Monitoring	C-1
Appendix D - Diffusion Model for Hoerner-Waldorf H ₂ S	D-1
List of Authors and Qualifications	

SUMMARY

The Hoerner-Waldorf Corporation (H-W) has applied to the Air Quality Bureau (AQB) of the State Department of Health and Environmental Sciences (SDHES) for a permit to expand its existing pulp and paper mill in Missoula, Montana.

Under the expansion plan, various pollution control devices would be installed, in addition to those already under construction to lessen emissions and discharges from the existing mill. If the expansion were allowed, air pollution would continue at a rate lower than at present, but higher than if the plant were not expanded but was operated with the pollution control measures now under construction or in the planning stage. Sulfur oxide emissions may increase with the expansion, but not to a level known to be hazardous to health or property.

Visibility could decrease after the expansion. The odor problem would continue to some extent, but with fewer and less severe episodes than at present.

Preliminary information indicates the expanded plant could be operated to comply with all air and water quality standards. Some economic benefits would accrue, from the expansion, but the extent and significance of these benefits is in contention.

It appears that the requested permit could be issued unless new information or further analyses of existing information indicate that pollution standards could not be met by the expanded mill.

I. INTRODUCTION

A. Description of the Proposed Action

H-W has applied to the Air Quality Bureau for a permit to expand the capacity of its pulp and paper mill from 1150 tons per day (TPD) of paper products to 1850 TPD. Operation of the expanded plant would affect air pollution from the mill, and therefore a permit is required under regulations resultant from the 1967 Clean Air Act of Montana. The act and subsequent regulations say there shall be no "installation, alteration, or use of any machine, equipment, device or other article which . . . may cause or contribute to air pollution . . ." unless a permit is issued.

The proposed expansion would cause increased emission of sulfur oxides, total reduced sulfur (TRS), and particulate matter despite improvements in emission control efficiency that would accompany expansion.

A more detailed explanation of the air pollutants generated in the production of paper requires technical explanation of the process, which will be attempted in Section II of this statement. Air pollution sources and new types and methods of controls also will be discussed in the later section.

Other air pollution laws affecting the proposed expansion are listed in Appendix A.

H-W says that the 745 acres of ponds which receive the liquid discharge from the plant are the primary sources of air pollution caused by the paper making operation.

It appears that odorous hydrogen sulfide and perhaps small amounts of some other gases are released from the ponds as a result of the action of anaerobic bacteria. Generally, H-W will attempt to reduce odorous emissions from the ponds through the installation of an aeration system. If oxygen were

introduced into the ponds by an aeration system, aerobic bacteria would replace the anaerobic bacteria which generate hydrogen sulfide in breaking down the sulfate material produced by the mill. The proposed expansion would lead to a substantial increase in the amount of sulfate-containing liquid waste issuing from the plant. At present, 15.7 million gallons per day (MGD) of liquid effluent are discharged to the ponds. About one-third of the liquid entering the ponds is discharged to the river during spring runoff. The remainder either evaporates or infiltrates through the bottom of the ponds. If the proposed expansion were carried out, discharge to the ponds would increase to a level of about 21.6 MGD. Up to 325 acres of new ponds might be required.

The discharge of liquid effluents is controlled by the State Water Quality Bureau, which must issue a discharge permit each year for the spring discharge. Issuance of the discharge permit is contingent upon H-W's efforts to meet a compliance schedule which was designed to reduce the extent of water pollution from the mill. The compliance schedule is included in Appendix B. Following the schedule is some H-W correspondence regarding the feasibility of meeting it.

Section 301 (b) of federal Public Law 92-500 (the Act), requires the achievement by not later than July 1, 1977 of liquid effluent limitations for point sources, other than publicly owned treatment works, which require the application of the best practical control technology (BPCT) currently defined by the administrator of the EPA pursuant to Section 304(b) of the Act.

Section 301 (b) also requires the achievement by not later than July 1, 1983 of liquid effluent limitations for point sources, other than publicly owned treatment works, which require the application of best available technology (BAT) economically achievable. Section 306 of the Act requires the achievement by new sources of federal standards of performance for the control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the administrator determines to be achievable through application of the best available demonstrated control technology, processes, operating methods or other alternatives. The proposed expansion would be subject to the best practicable treatment standards.

The EPA development document details the analyses undertaken in support of the proposed regulations. (1) An EPA economic analysis of the industry also has been published. (2) The guidelines and standards for the unbleached pulp, paper and paperboard manufacturing point source category were published in the Federal Register on May 29, 1974 (Volume 39, No. 104, Part I) and summarized below:

	<u>Best Practicable Treatment</u>	<u>Best Available Technology</u>	<u>New Source Performance Standards</u>
Biochemical Oxygen Demand BOD ₅ (lbs/ton of production)			
Maximum for any one day	11.2	5.4	5.4
Maximum average daily values for 30-day periods	5.6	2.7	2.7
Total Suspended Solids TSS (lbs/ton of production)			
Maximum for any one day	24.0	7.4	7.4
Maximum average daily values for 30-day periods	12.0	3.7	3.7

	<u>Best Practicable Treatment</u>	<u>Best Available Technology</u>	<u>New Source Performance Standards</u>
Color (lbs/ton of production)			
Maximum for any one day	No specific requirement	30	30
Maximum average daily values for 30-day period	No specific requirement	20	02
pH	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0

Regulations for the bleached pulp industry are yet to be issued. These may require additional treatment of the bleach plant wastewater above that presently proposed by H-W.

The EPA also has issued regulations for the National Pollutant Discharge Elimination System (NPDES) program, as printed in the Federal Register on May 22, 1973 (Volume 38, No. 98, Part III).

The EPA has issued a public notice of its proposal to issue a waste discharge permit to Hoerner-Waldorf Corporation, and a public hearing was held at Missoula on May 29, 1974. The proposed permit would expire on June 30, 1979.

The federal NPDES program mentioned above came under state authority as of June 10, 1974. A regulation (MAC 16-2.14(10)-S14460) entitled "Montana Pollutant Discharge Elimination System" (MPDES) was adopted by the State Board of Health and Environmental Sciences on January 18, 1974, and this regulation became effective on March 8, 1974. This regulation was adopted to provide Montana with a program comparable to that of EPA.

The state waste discharge permit will be in effect until the NPDES or MPDES permit is issued. This permit must now be issued or denied by the state, since EPA turned over the MPDES program to the State Department of Health and Environmental Sciences. Major requirements of this existing state wastewater discharge permit are summarized in Appendix B.

To meet the compliance schedule established by the State Department of Health and Environmental Sciences H-W has ordered aeration equipment and has a two-stage aeration basin partially constructed. The new treatment system will include ten 150-horsepower mechanical aerators in the first stage of the basin with two similar aerators in the second stage, all of which will follow the existing clarifier. The aeration basin will have an area of approximately 35 acres and an average depth of 12 feet. At the present level of production, each stage of the aeration basin would have a detention time of about four days. Based on the design submitted by H-W, the 1800 horsepower aerator installation would reduce the BOD₅ concentration from an average of 480 milligrams per liter entering the basin to a level of 24 milligrams per liter (under winter conditions) for the present mill. This represents an efficiency of 95 percent. It is expected that further BOD₅ reduction will be realized in the first ponds (1 and 15) following the aeration basins. The consultants for H-W indicate that the BOD₅ concentration in the treated wastewaters directly discharged to the river will be about 7 milligrams per liter.

H-W predicts that 2,160 pounds per day of nitrogen and 450 pounds per day of phosphorus will be required to facilitate BOD reduction by bacteria for the existing production level. For the expanded mill, 2,430 pounds of nitrogen and 510 pounds of phosphorous would be required daily. Some of the added nutrients would be removed from the treated wastewater by seepage, but the removal efficiency can only be roughly estimated.

Some of the nutrient needed by the bacteria is contained in wastewaters generated in the paper making process, but not enough, so some will have to be added in liquid form to the clarifier effluent.

At the expanded production level, each stage of the aeration basin would have a detention time of more than 2.5 days. According to the design submitted by H-W, the aeration basin will reduce the BOD₅ concentration from an average of approximately 310 milligrams per liter entering the basin to approximately 30 milligrams per liter (under winter conditions) for the expanded mill. The consultants for H-W indicate that the BOD₅ concentration in the treated wastewaters directly discharged to the river will be approximately 13 milligrams per liter for the expanded mill.

In addition to reducing BOD₅ of the effluent, the aerated treatment should substantially reduce the odor problem associated with the ponds used for aeration, settling, and storage, and should reduce the effluent toxicity, taste and odor characteristics, and foaming tendencies. The concentration of phenol in the effluent probably will be reduced to 0.1 milligram per liter. Little color reduction can be expected by this treatment. Some odors may emanate from the ponds for a short period of time during the spring ice breakup.

Sludge disposal from the clarifier will continue as it is with sludge pumped to Pond 4 (23 acres), which has sludge holding capacity for an additional ten years. This pond will remain anaerobic and continue to give off odors.

As indicated elsewhere in this report, the major volume of wastewater is disposed of by seepage to the groundwater, which in turn reaches the river. The ponding system has been expanded as seepage has been reduced in the older ponds. H-W is presently experimenting with rapid infiltration basins, which, if as successful as predicted by H-W consultants, will permit ground disposal of the majority of the treated effluent. The proposed infiltration system

would follow the aerated stabilization basins and settling ponds as described later in this report.

Under the proposed expansion program, a variety of measures would be taken to purify liquid effluents before they were discharged to the clarifier. These measures require technical explanation which will be furnished in Section II of this statement, where there is a further discussion of the proposed water pollution control techniques, and the types and amounts of pollutants likely to be generated.

The laws applicable to water quality can be found in Appendix B.

According to H-W, the proposed expansion would require new installations in various parts of the plant, as follows.

WOODYARD

1. New hydraulic platform truck dumpers to replace the Number 1 and 2 cable hoist dumpers.
2. The pneumatic blowing systems, which take the chips from the truck dumpers and deliver them to storage or process, will have their capacities increased in order to reduce the cycle time per truck, and therefore meet the capacity requirements anticipated at peak unloading rates.
3. The increased utilization of sawdust pulp means that the outfeed system from the existing Atlas bin will need to be upgraded and its capacity increased to handle the projected design rates.
4. A new dump, storage area, and reclaim facilities for sawdust are planned in the northeast corner of the woodyard storage area next to Mullan Road.
5. The existing veneer chip reclaim system needs to be upgraded so that it will have the capacity to feed the digesters at the increased rate required for 1850 tons per day.
6. A tramp material separator system will be installed in line with the existing belt conveyor to the existing chip kamyr. This installation is required to protect the blow line refining system that will be installed as part of the pulp mill expansion.
7. The existing Atlas Sawdust Bin will be used for storage of pin chips, and the out-feed system changed to meet the new requirements.

8. A new access road to the new sawdust dumper is required within the plant grounds because the load restrictions on Mullan Road prohibit the travel of loaded chip trailers over its surface.

PULP MAKING

Changes in the pulping area include the following:

1. A new sawdust digester will be installed to produce about 340 tons of pulp per day. Relief gases from the digester will be routed through a turpentine condenser and then to the lime kiln.
2. A washing system will be installed for the sawdust pulp.
3. Blowline refining and additional washing facilities will be installed to increase yield and maintain minimum chemical losses.
4. Additional tankage for hi-density stock storage will be provided.
5. A knotter and two fibrilizers will be added to allow an increased pulping rate on the batch digesters.
6. An additional tank for storage of bleached pulp will be included. This bleached pulp will be used only to make spru-white linerboard.

PAPER MAKING

Market requirements indicate that the most efficient trim for linerboard is in multiples of 80". The expansion therefore includes a new No. 3 Paper Machine with a width of 320 inches. This machine will be a swing machine, capable of producing both linerboard and bag paper.

The No. 1 Paper Machine capacity will be expanded slightly by the addition of a high nip pressure press in the third position in order to meet the 1850 T/D goal.

STOCK PREPARATION NO. 3 PAPER MACHINE

This area includes stock chests required for the proper refining and blending of stocks; stock transfer pumps, consistency regulators; piping; white water system including savealls; and chemical additive system modifications.

NO. 1 PAPER MACHINE MODIFICATION

The modification required to enable No. 1 Paper Machine to meet the anticipated production goals for this machine at the 1850 T/D level of production are minimal in nature. They consist of substituting a new high nip pressure press, with its drive, in place of the existing No. 3 Press.

ROLL HANDLING AND WAREHOUSING

The existing warehousing and rail car loading dock will be demolished in order to make room for the No. 3 Paper Machine Building.

The facilities provided as part of the new expansion includes 48,000 square feet of net storage area, and provides the housing for the necessary roll lowering equipment to bring the rolls from the dry end of No. 3 Paper Machine to the loading docks.

LIQUOR EVAPORATION

The 1850 T/D level requires the addition of evaporators, condensers and tanks as well as extensive repiping. All noncondensable gases will eventually be channeled to one of the lime kilns for thermal oxidation.

RECOVERY BOILERS

The 1850 T/D production rate will require that the No. 2 Recovery Boiler be modified in order to meet the new emission standards and to burn the additional black liquor solids generated at this capacity. This modification will include an economizer and new precipitator. The electrostatic precipitator will be sized to meet the particulate emission standards.

STEAM GENERATION

A new steam generating boiler will be installed to provide the steam required using natural gas as the primary fuel. Additional feedwater treatment and auxiliary equipment will be installed as required.

EMERGENCY FUEL OIL SYSTEM

The growing shortage of natural gas and the increased need for fuel because of the increased expansion of production make it essential to install a new emergency fuel system. This system includes a 1,000,000 gallon fuel oil storage tank and an efficient unloading station. This large storage capacity will help insure H-W's ability to purchase the required low sulfur oil when it is available.

RECAUSTICIZING

Expansion to 1850 T/D requires a complete recausticizing plant including a kiln, slaker, three causticizers, white liquor clarifier and mud washer. Included with the kiln will be a scrubbing and monitoring system as required by the Montana state emission standards.

RELOCATION AND DEMOLITION

The major items of relocation and demolition are as follows:

1. The new Kamyr Sawdust Digester necessitates the demolition of the existing lunchroom.
2. In order to make room for the new lime kiln, several tanks will be relocated. They will not be demolished since they were required for the new operation as well as the existing. A new chemical unloading station is also included, since the existing unloading station is in the way of the recausticizing expansion.
3. The addition of the No. 3 Paper Machine requires the demolition of the existing warehouse and rail car loading docks.

ELECTRICAL DISTRIBUTION

The necessary electrical distribution equipment as well as the secondary wiring required for the mill expansion will be installed.

SEWERS

The existing sewers will be relocated and new sewers constructed as necessary to provide adequate service to the new facilities. All sewers will enter the existing effluent system ahead of the clarifier.

GAS FACILITIES

Included is a new gas line to the new boiler location and rework and relocation of the gas lines necessary to service the new lime kilns.

WATER SUPPLY

Four new wells are required. The increase in pumping rate through the existing pipe line will increase the friction to the point that it will be necessary to upgrade the existing pumps to increase their maximum potential head.

FIRE PROTECTION

The underground fire protection main, which loops the existing mill facilities will require extensive relocation. Installing sprinklers in the new paper machine and warehousing buildings is also included in the project.

EFFLUENT TREATMENT

The modifications to the existing mill facilities required to achieve the desired mill production expansion will result in a much lower loss of solids and BOD per ton of production than is currently being experienced. It is anticipated that total pounds per day of suspended solids and BOD entering the clarifier will be no higher than from the existing operation.

A commitment has been made to the State and Federal agencies that additional treatment capability will be added in 1975 in order to reduce the current BOD load to the river. This installation will be sized for the expanded mill.

The effluent treatment system is therefore based upon a continuation of the present practice of ponding effluent and discharging directly to the river only during the 6 to 8 weeks' spring runoff period. The mill, assuming that some minimum seepage rate can be maintained, has calculated that approximately 325 additional acres of ponds may be required to handle the increase of daily effluent volume of 5.9 million gallons.

No additional primary clarification is required since the anticipated load to the clarifier will not exceed the capacity of the existing clarifier.

RAILROAD

The existing plant site facilities include a rather extensive system of tracks used for marshalling the cars. The addition of the No. 3 Paper Machine Building has required the elimination of many of these tracks; therefore, there is an extensive amount of track work included in the expansion to provide access to the woodyard as well as to the rollshipping dock.

II. DESCRIPTION OF PLANT AND PROCESS

A. Basic Manufacturing Process

The Kraft or sulfate method of paper making used by H-W is forecast to remain the most popular of the various processes. The groundwood, semi-chemical (NSSC or neutral sulfite semi-chemical pulping), soda, and sulfite processes accounted for less than 29% of the 1964 wood pulp production of 32,428,000 tons in the U. S. In the U. S. in 1970 these methods accounted for less than 10% of the 36,400,000 ton production.

Only the Kraft process used by H-W at Missoula will be discussed in this statement. The Kraft process uses an alkaline solution of sodium hydroxide (NaOH), sodium sulfide (Na₂S) and sodium carbonate (Na₂CO₃) for cooking, or digesting wood chips to a pulp suitable for paper manufacture.

Raw materials for the plant are obtained either in the form of sawmill waste or directly from the forests as roundwood. Most of the pulp is produced from chips from sawmill residues although a lesser amount of roundwood is used. H-W uses some sawdust and the proposed expansion would use an increased percentage of sawdust as raw material. When roundwood is used, it must be chipped before it enters the paper making process.

The raw materials are introduced into digesters and white or cooking liquor is added. The liquor removes the lignins from the wood leaving a fibrous cellulose pulp. After digestion the pulp is washed to remove the cooking chemicals and dissolved organics and transported to the paper machines. The wet pulp is dewatered mechanically and thermally and pressed into a continuous belt of Kraft linerboard paper.

After leaving the digesters, the pulp is washed, producing a relatively dilute stream of chemicals in a solution known as weak black liquor. The weak black liquor containing about 15% solids is concentrated by the evaporation of water to produce strong black liquor. Black liquor contains large

quantities of organics (lignins) dissolved from the wood. The heat value of the lignins is extracted by burning the liquor in recovery furnaces and the non-combustible chemicals are melted and recovered as smelt. The smelt is dissolved and makeup chemical added to form green liquor. The green liquor is further chemically and mechanically processed to regenerate the white cooking liquor. Figure 1 illustrates the Kraft pulping process.

DETAILED DESCRIPTION OF BATCH DIGESTION

H-W employs two digesting methods-continuous and batch. In the batch process, the digesters are sequentially filled, cooked and emptied.

Only chips are batch digested with 1260 tons per day (TPD) charged into the 8 cylindrical mild steel digester vessels. After the chips are charged, cooking liquor, a solution consisting principally of NaOH and Na₂S with varying amounts of Na₂CO₃, sodium sulfate (Na₂SO₄), sodium sulfite (Na₂SO₃) and thio-sulfate (Na₂S₂O₃), is added, and live steam is introduced after the vessel is closed. Cooking is carried out at about 340°F and 100 psig for about four hours.

At the end of the cook, the contents of the digester are "blown" into a tank. A considerable amount of steam flashes off along with some odorous gases. These gases are vented to an accumulator which is a large tank containing cold water and a large vapor space. The accumulator serves to reduce the volume of digester blow gases and condenses some of the odorous compounds, prior to transport of the gases to the lime kiln for incineration.

CONTINUOUS DIGESTION

Besides its batch digesters, H-W has two continuous digesters, one of which can produce up to 900 TPD (dry weight) of pulp, and the other up to 150 TPD. These two digesters together can process up to 3200 TPD of chips (wet weight). The expansion would add a 275 TPD digester which could process

up to 1430 TPD of wet sawdust.

In the continuous digester process chips and sawdust are transported pneumatically to screening units, presteamed, and fed continuously along with white liquor to the tops of the digesters. The continuous digesters are always full, with fresh material added continuously to the top and digested pulp continuously withdrawn from the bottom. The pulp-liquor mixture removed from the bottom of the continuous digesters follows the same route as the digested pulp from the batch digesters.

It is first transported to the washers for chemical removal. The pulp washers are a series of rotary vacuum filters with water sprays. Contaminated condensate from the evaporators is used to wash pulp in the washers, where it first enters the last washer in the sequence, from whence issues the washed pulp. After use in the last washer, the contaminated condensate, now dirtier than it was when it entered the first washer, is used in turn in the second to last stage, then the third to last stage, and so on until it emerges as weak black liquor from the first washer where the unwashed pulp enters. The pulp and wash water thus move in opposite directions through the washers, with the one getting dirtier as the other gets cleaner.

The liquor issuing from the first stage of the washers contains nearly all the chemicals used plus the dissolved organics in a solution of about 15 percent solids. The chemicals retained in the pulp after washing currently consist of about 60 pounds of Na_2SO_4 (soda) per ton of air dried pulp produced (TADP).

After washing the pulp is transported to one of three paper machines and diluted to 1/2 percent solids. The pulp is placed on a moving wire screen where much of the water is drained off. The partially dewatered pulp still on the screen is fed to a series of steam heated roller presses, where the remainder of the water is driven off and the pulp becomes Kraft paper which

is wound on rolls for shipment.

The remainder of the plant is largely devoted to recovering chemicals from the weak black liquor. Chemical costs are one of the major expense of paper production, so it is economically desirable to minimize chemical losses.

Weak black liquor from digesting is collected from the brown stock (pulp) washers and from the flash tank on the 900 TPD Kamyr continuous digester. At this point the liquor contains about 13-16% black liquor solids (chemical and organic) and is fed to the multiple effect evaporators. These evaporators contain several consecutive stages or "effects" for evaporation to achieve optimum use of the steam, which supplies the heat to evaporate the water. Additional evaporation is obtained by varying the pressure (vacuum) of the various effects to alter the boiling point of the black liquor. The product of the evaporators is strong black liquor containing 50 to 55 percent black liquor solids.

The strong black liquor is stored and fed to the concentrators for further dewatering. This additional dewatering is needed as the black liquor will not burn until the solids concentration reaches 64-66 percent. The concentrators operate in the same manner as the multiple effect evaporators.

After the liquor is concentrated enough to be combustible, it is stored to await burning in the recovery furnace. From the storage tanks, the liquor is fed to mix tanks, where makeup chemicals are added. Purchased salt cake (primarily Na_2SO_4), fly ash from the precipitator (also Na_2SO_4), and caustic are added as necessary to give the proper chemical composition to the white liquor which will eventually result from combustion of the black liquor. After the chemicals are added, the black liquor is sprayed into the recovery furnace where the organic wood products burn and the inorganic chemicals melt

and fall to the bottom of the furnace. At present, 4.4×10^6 pounds of black liquor solids are fired each day and the expanded mill would burn about 5.3×10^6 lbs/day. The furnace also serves as a boiler, and considerable heat is extracted as steam from the combustion process. The inorganic chemicals are tapped continuously, as smelt, from the furnace bottom into smelt dissolving tanks. The smelt, mostly Na_2CO_3 and Na_2S , is dissolved in wash water from the lime kiln mud washers. The resulting green liquor is clarified and stored for further processing.

The green liquor eventually is causticized with slaked lime ($\text{Ca}(\text{OH})_2$) to regenerate the sodium compounds in the chemical forms needed for digestion. Sodium carbonate, one of the recovery furnace products, is converted to sodium hydroxide by the lime in the causticizing process. The resulting white liquor is clarified to remove the undissolved (CaCO_3) solids, after which it is ready for reuse in the digesters. The CaCO_3 is washed, dewatered, and fed to the lime kiln for regeneration to CaO . The wash water is used for smelt dissolving.

Ancillary mill facilities include the bleach plant, power boilers, turpentine condenser, tall oil reactor and water treatment systems.

The bleach plant is not normally used as the paper products ordinarily are marketed as high strength linerboard, which need not be bleached.

The power boilers produce steam to supplement that produced by the recovery furnaces. H-W's proposal includes provisions for conversion of the #1 recovery boiler to a power boiler and addition of one new power boiler fired by hogged fuel and gas or oil.

The turpentine condenser processes overhead vapors from the digesters and evaporators to produce marketable turpentine.

The tall oil reactor is another special byproduct chemical producer using soaps removed from the black liquor as feed stocks to make tall oil,

a mixture of rosin acids and fatty acids, used in making paint, alkyd resin, linoleum and many other materials.

B. Sources and Nature of Pollution

AIR POLLUTION

Nearly every item of process equipment in a pulp and paper mill can contribute to pollution of air and water. Air pollutants generated in the pulping process are many and varied. Gases and particulates are emitted as a variety of compounds. Many of the gaseous emissions are odorous, among them hydrogen sulfide (H_2S), methyl mercaptan, (CH_3SH), dimethyl sulfide (CH_3SCH_3) and dimethyl disulfide (CH_3SSCH_3). Other gaseous pollutants emitted are sulfur dioxide (SO_2) and carbon monoxide (CO). Particulate emissions include wood fiber, sodium compounds from the recovery furnaces, fly ash, and calcium compounds. Table 1 summarizes the various pollutants and sources. Air pollution starts with the first step in the plant operation. Dust is generated as the wood raw materials--chips, sawdust and roundwood--are brought to the plant by truck and rail, dumped, and transported to storage. There is more dust as the roundwood is debarked, chipped, and moved to the digesters by pneumatic conveying systems. The cyclone dust collectors used at transfer points allow fine wood particles to escape to the atmosphere and wind entrains some of the finer wood particles from the raw material storage piles.

The batch digesters are the next source of emission in the process line. Most of the odorous gases generated in a pulp and paper mill are created by reaction of the lignins from the wood with sulfur from the white liquor. To maintain the proper temperature and pressure in the digester vessels, gases containing sulfides and mercaptans are bled off. These overhead vapors are collected and vented to the turpentine condenser for recovery of organic byproducts. When the batch digester charge is cooked, it is

Table 1

	CASES					PART.			
	SO ₂	H ₂ S	CH ₃ SH	(CH ₃) ₂ S	CH ₃ SSCH ₃	Wood Paper	Fly Ash	Calcium	Sodium
Raw Materials Handling						X			
Digesters		X	X	X	X				
Pulp Washers		X	X	X	X	X(T)			
Bleach Plant									
Paper Machines						X(T)			
Evaporators/Concentrators		X	X	X	X				
Turpentine Condenser		X	X	X	X				
Tail Oil Reactor		X	X	X	X				
Recovery Furnaces	X	X	X	X(N)	X(N)		X		X
Smelt Tanks	X(T)								X
Lime Kilns		X						X	
Slakers Hog Fuel Boiler						X	X		
Gas/Oil Boilers	X						X		

(T)Trace

(N)Negligible

emptied into a tank (or "blown"). Large volumes of steam and odorous gas are released and vented to a condenser and accumulator for reduction of volume. The remaining non-condensibles are vented to the lime kiln for incineration.

Off-gases from continuous digestion are treated in much the same manner with the addition of vapors from the steaming vessel.

As the pulp is washed on the vacuum washers TRS is liberated. The washers are hooded and ducted to remove TRS and water vapor to the atmosphere. H-W originally intended to incinerate this TRS in a boiler but has since abandoned the idea.

The bleach plant and paper mill are not significant sources of air emission although small (almost unmeasurable) quantities of wood particulate are discharged.

The pulp washer filtrate contains most of the chemicals used in the process and most of the organics removed from the wood. This weak black liquor is evaporated and concentrated as previously described. The water driven off contains significant quantities of TRS. After passing through condensers after each evaporation sequence, significant quantities of TRS remain uncondensed. These gas streams vent to the accumulator--turpentine system with final disposition in the lime kilns. Similarly generated odorous non-condensable gases from the concentrator vent directly to the atmosphere. With the proposed expansion, concentrator gases would be incinerated in the lime kiln also.

The condensates from these systems pass to a sewer. In the sewer dissolved TRS compounds are liberated to the atmosphere as a result of air contact and pH changes. Further emission occurs at the effluent treatment system. H-W has determined that the condensates cause emission of 1600 #/day of TRS in the mill and 1200 #/day at the wastewater treatment ponds.

The greatest single source of odor apparently is the pond system itself. The effluent discharged to the system contains on the average

1340 milligrams/liter (mg/L) of dissolved sulfur as sulfates. The pond system in general is anerobic (oxygen deficient) and in this situation certain bacteria are active. These bacteria reduce the sulfate compounds to sulfides by removing the chemically bound oxygen for use in respiration. According to H-W the product of the respiration is 17,000 pounds/day of H_2S . As noted previously, H-W has undertaken a program to aerate the ponds and raise their oxygen content enough to make them aerobic, thus preventing the reduction of sulfate to H_2S and diminishing the odor.

To further reduce the odor the condensate stream will be air stripped to remove the odorous gases which are then incinerated in the lime kiln. Present emissions from the condensate stream are 2805 #/day which would increase to 4510 with expansion if the stream were not controlled. The expected 90% control would reduce emissions from this source to 451 #/day of TRS.

The concentrated black liquor is delivered to the recovery furnaces for burning of the organics and recovery of cooking chemicals. The recovery furnaces were at one time the major source of pollution from pulp mills, including the H-W operation. They remain the major source of particulate matter but not of TRS, at least at the H-W plant. At an average of 5 ppm TRS as H_2S in the flue gas, H-W's two recovery furnaces emit 172 #/day. This compares with 1970 emissions of 11,340 #/day at H-W. Particulate matter from the furnace is controlled by electrostatic precipitators which ultimately emit 2,250 #/day. Sulfur dioxide is a recent addition to pulp mill emissions as a result of conversion to the low odor furnace. H-W's #3 and #4 furnaces presently emit 6,490 #/day of SO_2 .

After the proposed expansion, recovery furnace emissions would be 211 #/day TRS, 5,000 #/day SO_2 and 2,663 #/day of particulate according to H-W.

When the chemicals recovered in the recovery boilers are dissolved in liquor at the smelt dissolving tank, 1,220 #/day of particulate and 4 #/day of TRS compounds are emitted. The expansion would boost these emissions to 1,340 and 7.5 #/day according to H-W.

As noted, the lime kilns serve as TRS incinerators besides burning CaCO_3 to CaO . If not properly operated, the kilns will emit TRS not only as a result of incomplete combustion but also by generating odorous compounds from the sulfur containing feed mud. H-W testing indicates emissions of 520 #/day of particulate and 219 #/day of TRS from the kilns. For the proposed expansion the lime kiln emissions are forecast at 840 #/day particulate and 353 of TRS.

The steam boilers emit fly ash and SO_2 in quantities depending on fuel composition. The hogged fuel boiler, equipped with wet scrubbers, discharges 200 pounds of particulate per day to the atmosphere. The fossil fuel boilers, could emit up to 33,000 #/day of SO_2 when firing fuel oil. Fly ash emission is not significant from boilers burning gas, and not major from oil fired boilers. The oil boilers can emit unburned carbonaceous particles if not properly operated. The wood waste boilers emit 200 #/day of particulate matter. The expanded mill would have a new wood-fired boiler which is predicted to emit 600 #/day of particulate after scrubbing. This boiler would operate on wood fuel as supplies permitted. H-W intends that this boiler be fired on wood during periods of natural gas curtailment to avoid the use of oil in boilers which have no SO_2 emission control. Oil would be burned in the converted #1 boiler which would be equipped with a 99% efficient SO_2 scrubber.

WATER POLLUTION

There are three major pollutants in the wastewater from the pulp, paper, and bleach plant. These are the biochemical oxygen demand (BOD), which is a measure of the oxygen required to biologically stabilize the

organic materials, total suspended solids (TSS), which are the solids that can be removed by filtration, and color. BOD is usually expressed in terms of five-day BOD (BOD₅). Color bodies in wastewaters from pulp and paper mills are lignin-like in character and are reported to be lignins which have been degraded to various degrees.

The major sources of BOD are the pulp washing operation, evaporator condensates, and spills and overflows. The actual papermaking stage of the process causes little BOD, and almost all the BOD in the effluent from the papermaking process is that which was not removed in the pulp washing process.

To assist the EPA in the preparation of its Development Document (1), four unbleached pulp and paper mills were surveyed to determine their pollution control efficiency. The mills picked for the survey were ones with low discharge flows and low discharges of treated BOD and suspended solids. Each of the mills surveyed had raw (untreated) wastewater discharges of 9,500 to 13,500 gallons per ton, BOD₅ of 27 to 31 pounds per ton, and TSS of 21 to 56 pounds per ton. One of the four mills surveyed had a color of 567 units and another measured 286 units on a short term test.

In the state of the art review (3) "high bleaching" is reported to produce an effluent of 25,000 to 35,000 gallons per ton of product, 40 to 60 pounds of BOD₅ per ton, 20 to 30 pounds TSS per ton, and a color of 4,000 to 6,000 units. The color units calculate to 833 to 1,750 pounds per ton if it is assumed that the higher units could occur with the higher flows and the lower units could occur with the lower flows. For purposes of calculation only, so as to enable use of a total combined flow and color units to obtain a mass balance, one color unit is assumed to equal one milligram per liter.

An average of 159 tons (based on 350 operating days) of bleached

product was produced in 1973 by H-W. H-W reports 30,000 gallons of water are required per ton of bleached product. The discharge from the bleach plant would, therefore, average 4.8 million gallons per day (MGD). The total contaminated waste flow (not including the uncontaminated cooling water which is discharged separately) averaged 15.8 mgd. H-W reported an average of 1,187 tons of pulp was produced per day based on 350 operating days. H-W assumes the use of 10,000 gallon per ton for the unbleached pulp and paper operation and 4,000 gallons per ton for pulp production alone.

Bleaching is reported by H-W to contribute 31 pounds of BOD₅ per ton of bleached pulp. For 1973, BOD from the unbleached portion of the pulp and paper mill operation averaged 56 pounds BOD₅ per ton of pulp. Assuming 30 pounds of TSS per ton of bleached pulp, the average for the unbleached portion of the mill is 36 pounds per ton of pulp. The daily contribution of BOD and TSS is highly variable; mainly because of spills and overflows.

The principal source of color is the bleaching operation, even though a relatively low tonnage of bleached product is produced. Using an average color value of 3,000 units with a total wastewater flow of 15.8 mgd gives a total color of 395,000 pounds per day produced by the mill. H-W reports that 1,900 pounds per ton of color of bleached product or 302,000 pounds per day are produced by the bleach plant. The color from the unbleached pulp and paper operation is, therefore, estimated at 93,000 pounds per day (78 pounds per ton).

C. History of Pollution and Control at Hoerner-Waldorf

AIR POLLUTION CONTROLS

H-W's pulp and paper mill was built in 1957. The plant initially consisted of three batch digesters and the #1 recovery furnace, equipped with a wet scrubbing system that could collect 38-90 percent of particulate. In 1958, another batch digester was added. In 1959 the #2 furnace was added and equipped with an identical air pollution control system (APC). Two more batch digesters and the #2 lime kiln were added the same year. A hog fuel boiler was installed in 1963.

In 1964, H-W installed a black liquor oxidation system in an attempt to reduce odorous emissions from the recovery furnaces. A venturi scrubber replaced a less efficient scrubber on the lime kilns and an incineration system was added for some of the non-condensable gas streams. Another batch digester was put on stream that year.

The mill was expanded in 1966 with the addition of the #3 recovery boiler and the sawdust and Kamyr digesters. The furnace was equipped with the same APC equipment as 1 and 2, plus an additional venturi. All furnaces used a "direct contact evaporator" permitting gas contact and subsequent stripping of odorous compounds from the black liquor. Black liquor oxidation used at H-W to fix the sulfur compounds and prevent their stripping was the standard odor control method in U. S. mills.

In early 1968 the "low-odor" recovery boiler system arrived and on November 5, 1969, H-W announced Phase I of its APC program which was based on the conversion of its #3 recovery boiler to the low odor system. In early 1970, prior to the proposed modifications, total air pollutant emissions from the plant were estimated as follows.

TRS = 11,600 #/day

SO₂ = 0

Total particulate = 41,490 #/day

It seems that the TRS data were not quite correct, as H-W now calculates an additional TRS emission of about 19,805 #/day from the ponds and foul condensates.

In May, 1970, H-W presented its Phase II plan for replacement of No. 1 and 2 furnaces with a new low odor #4 boiler.

Construction for Phase I began in March of 1970 and was completed May, 1971. Phase II was commenced February, 1971, and completed a few months ago.

Wet scrubbers were installed on the slakers, reducing particulate emission from 9260 #/day to 130 #/day and on the hogged fuel boiler reducing particulate from 8700 #/day to 200 #/day. H-W testing indicates that total plant emissions currently are as follows, including TRS from the ponds.

TRS = 20,376 #/day

SO₂ = 5000 #/day

Particulates = 5329 #/day

Table 2 lists all inventoried emission sources and their daily total emissions from the present mill.

H-W has undertaken additional control programs--the most notable being the secondary treatment of the ponds--designed to further reduce emissions. These programs will be implemented regardless of whether the plant expands. Table 3 presents projected data for the mill with control programs implemented but no expansion. Table 4 represents projected emissions for the mill as the expansion is presently proposed.

TABLE 2
CURRENT EMISSIONS

Source	Pollutant	TRS #/day	SO ₂ #/day	Part. #/day
#2 recovery boiler		0	1250	0
#3 recovery boiler		55	to	1000
#4 recovery boiler		80	5000	890
Brown stock washers		91	0	984
#1 lime kiln		62	0	90
#2 lime kiln		62	0	250
#3 lime kiln		110	0	180
#4 lime kiln		0	0	0
#1 and 2 slaker			0	65
#3 slaker			0	65
#4-slaker			0	0
#2 smelt dissolving tanks		0	0	0
#3 smelt dissolving tanks		2.3	0	870
#4 smelt dissolving tanks		2.4	0	290
Foul condensate streams		2,805		
Ponds		17,000		
Tall oil Reactor		88		
Existing Wood boiler		0	0	200
New wood boiler		0	0	0
#1 recovery - power				
Existing Package Power				
Raw materials conveying system		0	0	445
Miscellaneous odor sources		18.5		
		20,376	1250 to 1500	5329

TABLE 3

FUTURE MILL, NO EXPANSION

Source	Pollutant	TRS	SO ₂	Part.
#2 recovery boiler		0	1250	0
#3 recovery boiler		55	to	1000
#4 recovery boiler		00	5000	890
Brown stock washers		91	0	984
#1 lime kiln		62	0	90
#2 lime kiln		62	0	250
#3 lime kiln		110	0	180
#4 lime kiln		0	0	0
#1 and 2 slakers		0	0	65
#3 slakers		0	0	65
#4 slakers		0	0	0
#2 smelt dissolving tanks		0	0	0
#3 smelt dissolving tanks		2.3	0	870
#4 smelt dissolving tanks		2.4	0	290
Foul condensate streams		0	0	0
Ponds		404	0	0
Tall oil Reactor		1	0	0
Existing wood boiler		0	0	200
New wood boiler		0	0	0
#1 recover - power				
Existing power				
Raw materials conveying system				445
Miscellaneous odor sources		18.5	0	0
		1324.2	1250	5329
		or	to	
		469.2	5000	

TABLE 4

EXPANDED MILL AS PROPOSED

Source	Pollutant	TRS #/day	SO ₂ #/day	PART. #/day
#2 recovery boiler		39	1990	410
#3 recovery boiler		55	to	1000
#4 recovery boiler		117	7950	1253
Brown stock washers		146	0	317
#1 lime kiln		25		90
#2 lime kiln		25		250
#3 lime kiln		44		180
#4 lime kiln		51		320
#1 and 2 slaker				65
#3 slaker				65
#4 slaker				80
#2 smelt dissolving tank		2.2		120
#3 smelt dissolving tank		2.3		870
#4 smelt dissolving tank		3.0		350
Foul condensate streams		451		
Ponds		404		
Tall oil Reactor		1		
Existing wood boiler		0	0	200
New wood boiler		0	0	0
#1 recovery - power				
Existing package power				
Raw materials conveying system				271
Miscellaneous odor sources		23.5		
		1389	1990 to 7950	6441

WATER POLLUTION CONTROLS

The existing plant wastewater disposal system and the proposed system are schematically shown in Figure 2; Figure 3 is a map of the area. In the existing treatment system, a mechanical clarifier removes about 65 percent of the suspended solids and 96 to 98 percent of the settleable solids. Sludge from the clarifier is pumped to Pond #3 and #4. Little BOD is removed in this operation. The clarified effluent enters the shallow ponds which act as stabilizing basins. The clarifier and ponds reduce the BOD₅ concentration from about 560 mg/l to 300 mg/l by the time it reaches the lower ponds. The average BOD₅ concentration of all the ponds is somewhere between these two values.

The main portion of the BOD₅ reduction occurs as the effluent percolates through the pond bottoms and travels through the groundwater system. On the basis of groundwater samples obtained from test wells located between the ponds and the river, it is calculated that the BOD₅ concentration is reduced about 90 percent by the combination of pond storage and seepage.

After releasing about one-third of the effluent volume directly to the river under controlled conditions during the spring runoff, the overall BOD₅ reduction from the total system is estimated at 74 percent.

Ponds have been added through the years, and there are now a total of about 750 acres of storage and seepage ponds with liquid depths ranging from four to 12 feet. Ponds #14, 15 and 16 were constructed in 1970, 1971 and 1973 respectively. A portion of Pond #16 presently is being used for rapid infiltration studies. About 90 percent of the seepage occurs through Ponds #14, 15 and the two experimental rapid infiltration ponds. Ponding alone essentially removes no color. Problems associated with the existing disposal operation are:

WATER USAGE - WASTEWATER FLOW DIAGRAM

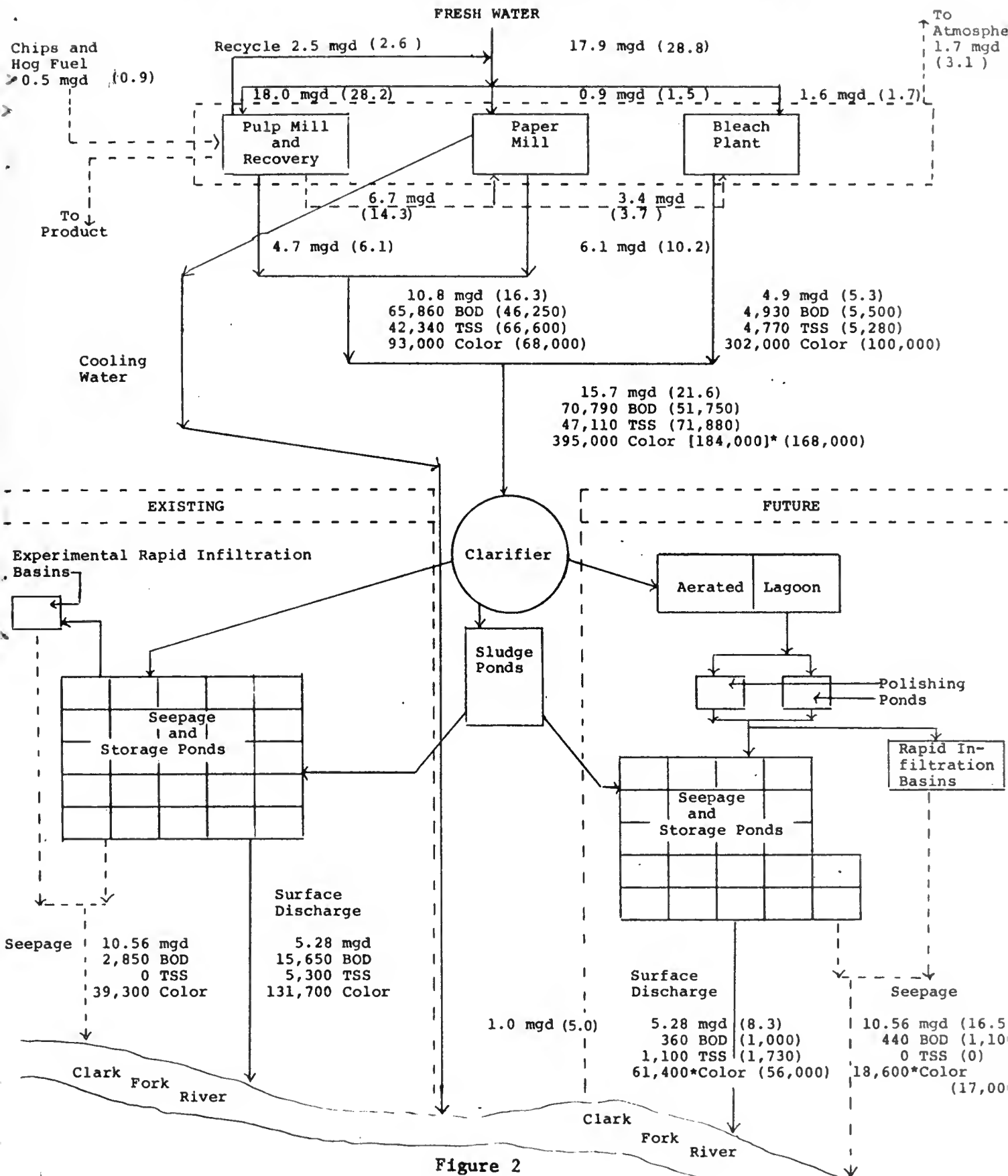


Figure 2

*After installation of APS and before expansion.
All values for BOD, TSS and Color in pounds per day.

NOTE: Numbers in parentheses are for the expanded mill. Numbers for the existing operation reflect values for 1973. All numbers are based on 350 days per year and disposal of one-third by direct discharge and two-thirds by percolation.

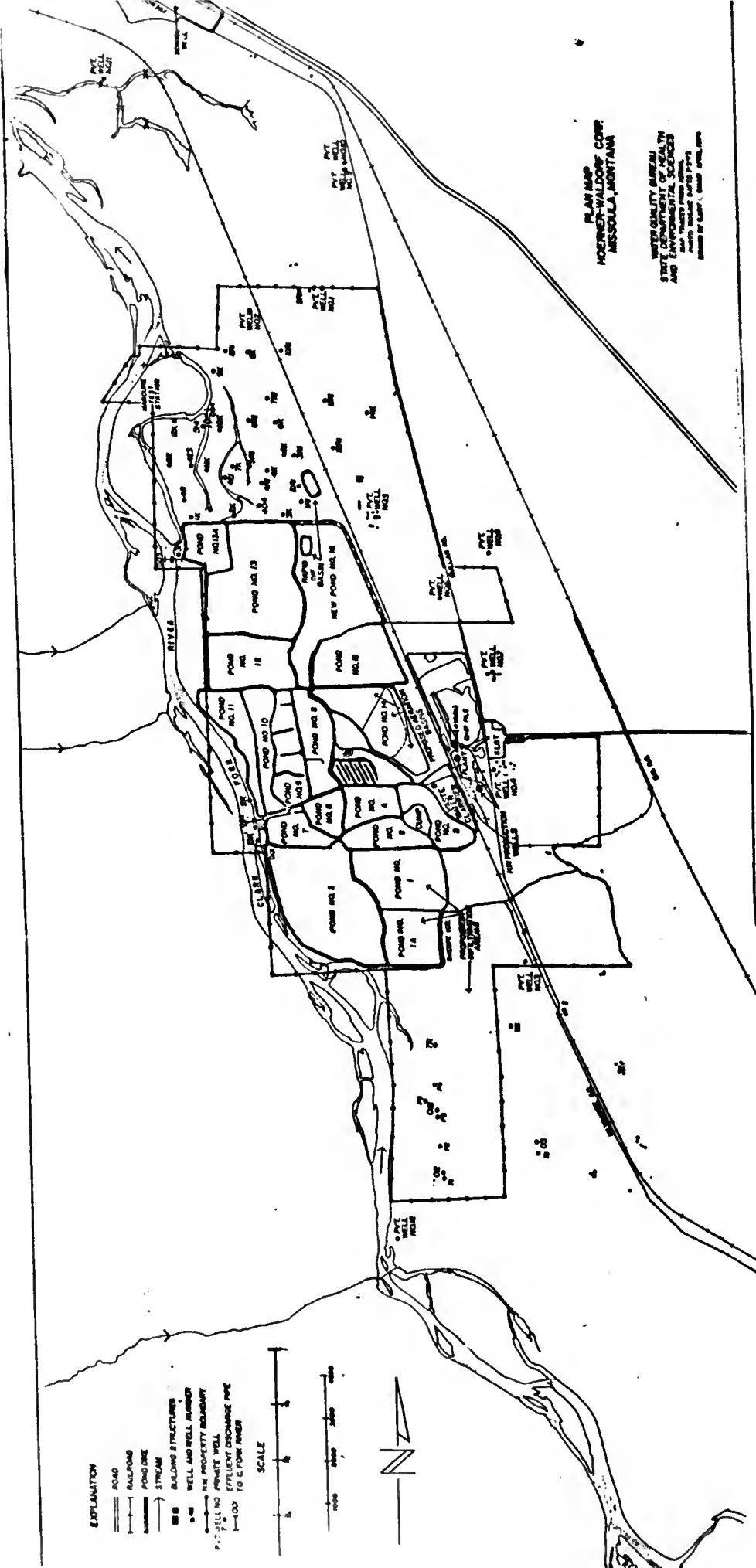


Figure 3

1. Present ponds are anaerobic which leads to hydrogen sulfide odors.
2. The percolation through the pond bottoms gradually decreases with time so that construction of new ponds is required periodically.
3. The existing treatment system is not sufficiently effective to allow the present mill to meet the color standards on the Clark Fork River.

The values listed below are average values of the wastewaters discharged from the ponds during 1971 as reported by H-W on the U. S. Army Corps of Engineers Application Form 4345-1. The values indicated should be about the same at this time.

<u>Parameter</u>	<u>Value</u>	<u>Parameter</u>	<u>Value</u>
BOD ₅	306 mg/l	Nitrate (as N)	0.1 mg/l
COD	1497 mg/l	Kjeldahl Nitrogen	4.3 mg/l
Total Solids	2360 mg/l	TOC	992 mg/l
TVS	1122 mg/l	Ortho PO ₄ (as P)	0.3 mg/l
TSS	97 mg/l	Total PO ₄ (as P)	0.7 mg/l
TDS	2263 mg/l	Bromide	0.2 mg/l
pH	8.0	Copper	20 ug/l
Alkalinity (as CaCO ₃)	678 mg/l	Lead	0.1 mg/l
Oil and Grease	38 mg/l	Mercury	2 ug/l
Chloride	216 mg/l	Nickel	32 ug/l
Sulfate (as S)	52 mg/l	Sodium	543 mg/l
Sulfide	1.5 mg/l	Zinc	88 ug/l
Sulfite	2.3 mg/l	Chromium (total)	10 ug/l
Phenols	0.3 mg/l	Color	2333 s.c.u.
Ammonia (as N)	0.5 mg/l	Specific conductance	2387 micromhos
Nitrate (as N)	0.4 mg/l	Turbidity	412 t.u.

COD = Chemical Oxygen Demand
 TVS = Total Volatile Solids
 TSS = Total Suspended Solids

TDS = Total Dissolved Solids
 TOC = Total Organic Carbon

Monthly reports on wastewaters have been submitted to SDHES since 1968. This information includes BOD, chemical oxygen demand (COD), TSS, and color on the clarifier influent and effluent and in addition, sodium, chlorides and conductivity on the clarifier effluent; BOD, COD, pH, sodium, chlorides, color, TSS, tannin on wastewater in the ponds and in the test wells; and dissolved oxygen, BOD, sodium, chlorides, color, TSS, and tannins from the river above and below the mill. The three river stations reported are Harper's Bridge

(about ~~two~~ miles above the mill), Marcure Ranch (on the same side and immediately below the mill and within the mixing zone) and Huson (Six Mile - about ten miles below the mill). Bioassays on fish (guppies) are also conducted and reported on wastewaters to be discharged.

D. Energy and Raw Material Consumption

The pulp and paper making process consumes large quantities of energy and raw materials. The H-W plant uses an average equivalent of 4,007 kilowatt hours (KWH) of energy per ton of product compared to 702 KWH/ton for lumber and 16,102 KWH/ton of aluminum. The major chemical and energy consumption for H-W's Missoula mill are given in Table 5. Some explanation and qualification of the table is necessary. The amounts given are based on a specific set of conditions--i.e., ratio of bleached/unbleached pulp, energy supplies, cost factors, raw material supply--and can and probably will vary from month to month and year to year. The data are presented for three sets of circumstances--the present mill, predicted for the mill in the future with no expansion, and for the future mill with expansion. Further discussion regarding the uses of natural resources can be found in Sections III and IV.

Table 5

HOERNER-WALDORF CORPORATION, MISSOULA MONTHLY WOOD, CHEMICAL, AND ENERGY USAGE

Material	Units	1973	1977 No Expansion	1977 Expanded Mill
Chips	Dry Tons	69,452	69,452	78,700
Sawdust	Dry Tons	2,432	2,432	17,700
Hogged Fuel	Wet Tons	7,840	7,840	19,000
Salt Cake	Tons	1,375	504	310
Caustic Soda	Tons	1,044	1,202	1,934
Spent Caustic	Tons	46	50	31
Lime	Tons	275	285	460
Chlorine	Tons	380	37 (59)	59
Sodium Chlorate	Tons	27	3 (4)	4
Sulfur Dioxide	Tons	15	3 (4)	4
Sulfuric Acid	Tons	563	437 (703)	703
Alum	Tons	449	449	730
Starch	Tons	608	608	669
Gum	Tons	32	32	97
Bulk Rosin	Tons	4	4	56
Natural Gas	MCF	388,000	388,000*	564,000
Fuel Oil	Gallons	92,000	92,000*	150,000
Purchased Electrical Power	Thousand KWH	12,830	20,140*	34,200

*Subject to changes due to supplies, prices, markets.

E. Wastewater Treatment and Control

From the data presented earlier in this report, it is obvious that substantial in-plant changes can make major improvements in effluent quality from the mill. Regarding in-plant changes, H-W (February 26, 1974) said:

To accomplish this major improvement, additional vacuum drum washing capacity will be added. The existing washing capacity will be increased from 4800 square feet to the equivalent of 12,310 square feet. This results in an increase in the ratio between washer surface area and pulp tonnage washed of 60 percent. In addition, the present spill collection system will be expanded to include facilities to collect losses from the new pulp washers, evaporator carryover, evaporator boil-outs, and recovery boiler water washing. These sources represent the major loss points in the existing mill. Also, sufficient evaporator capacity will be included to allow the collected liquor spills to be evaporated and retained in the process.

These changes will allow a significant reduction in the amount of color originating from sources other than the bleach plant. As a result, it is projected that the unbleached portion of our effluent will contain 500 color units, which is representative of the best unbleached Kraft mills in the United States. There have been recent occasions with the bleach plant not operating that the observed color of the total mill effluent achieved a level as low as 800 color units. From this evidence, it does not appear unreasonable to project a level of 500 color units for the unbleached portion of the expanded mill.

In addition to the improvements noted above, the expanded mill will include a revised bleaching sequence with the demonstrated ability to reduce the color of the effluent from the bleach plant by 70 percent. Called the Anti-Pollution Sequence (APS) by its developers, the Hooker Chemical Company, the process involves the replacement of caustic soda in the second bleaching stage with sodium hypochlorite as the bleaching agent. Full scale mill trials of this process were completed in early December, 1973, with the result that the color of the bleach plant effluent was decreased by 70 percent.

H-W indicated that the sewerable weak black liquor (0.84 mgd) will be eliminated with the new pulp washer system.

The actual loss of sodium to the sewerable wastewaters in the unbleached pulp and paper operation indicates the amount of BOD and color which will be present in the wastewater. H-W (April 9, 1974) gives the following figures:

SODIUM LOSSES (Pounds of Na/ton)

	<u>Present</u>	<u>Proposed</u>
Pulp washers (remains in pulp and removed in paper mill)	9.7	6.5
Severed filtrate	8.7	0
Spills, overflows and washups	$\frac{28.1}{46.5}$	$\frac{14.1}{20.6}$

Assuming that BOD will be reduced in proportion to the sodium reduction and using the existing BOD₅ of 56 pounds per ton, a BOD of 25 pounds per ton would be present. This compares favorably with the four mills surveyed by EPA. Using the same assumption, color would be reduced from 78 pounds per ton to 35 pounds per ton. As pointed out by H-W this is not a totally valid assumption as the condenser waters are low in color and high in BOD and the condenser flows will increase in almost a direct ratio to pulp production with the concentrations remaining about the same.

The following average discharge volume is computed:

Unbleached pulp: 3,300 gal/ton x 1850 tons = 6.1 mgd

Paper production 6,000 gal/ton x 1700 tons = 10.2 mgd

Bleached pulp: 30,000 gal/ton x 176 tons = $\frac{5.3 \text{ mgd}}{21.6 \text{ mgd}}$

This does not include uncontaminated cooling water presently discharged which H-W proposes to reuse in part or totally in the expanded plant.

Using the projected values for BOD and color and proposed production capacity of 1850 tons of pulp per day and projected production of the bleach plant of 176 tons per day, the predicted BOD and color values are:

	<u>BOD₅</u>	<u>Color</u>
Pulp and paper	$25\#/T \times 1850^T = 46,250$	$35\#/T \times 1850^T = 65,000$
Bleach	$31\#/T \times 176^T = \underline{5,500}$	$30\% \times 1900\#/T \times 176^T = \underline{100,000}$
	51,750 #/day	165,000 #/day

This compares with an average BOD of 71,000 # BOD/day and 395,000 pounds per day color in 1973. It is assumed that the pounds of TSS contributed per day per ton of bleached and unbleached pulp and paper produced will remain essentially the same with the expanded mill as with the present mill.

H-W has said that they will reduce color to 500 units in the pulp and paper operation (16.3 mgd). This would amount to 68,000 pounds per day of color. However, to reach this, an extremely efficient spill collection system will be needed along with adequate evaporator capacity to receive the collected spills.

The proposed means of waste disposal following aerobic treatment and settling is a combination of rapid infiltration and disposal through the ground, and storage and direct discharge. During recent years, the direct discharge to the Clark Fork River has been made only when the river exceeded 10,000 cfs in flow. An exception to this was made in 1973 when discharge was allowed (when the river was above 7,000 cfs). The major reason for prohibiting discharge during other periods was because of potential toxicity of the wastewater and the opinion of biologists that the discharge would be least critical at this time of the year. The data obtained to date indicates no apparent toxic effect to the fishery has occurred from this practice. With biological treatment in the ponds, the toxicity factor would be greatly reduced and a direct discharge during other periods of the year could be considered. The Department of Fisheries and Wildlife, Oregon State University, used experimental streams to determine the effects of Kraft mill wastewaters on salmonid fish. A summary of this study concluded in part:

Production of salmonid fish (cutthroat and brown trout, and coho and chinook salmon) was not affected, either favorably or unfavorably, by the presence of either primary treated or biologically stabilized kraft mill effluent at the 0.5 mg/l BOD level tested. Overall food organism abundance was not much affected by the presence of the effluents,

although there were changes in the relative abundance of different kinds of food organisms. Adjustments in the feeding habits of the fish apparently prevented the presence of the effluents from having any appreciable influence on the overall growth and production of the salmonid species studies. (4)

H-W indicates that up to 325 additional acres may be utilized for infiltration and storage. Some of the existing ponds are located on the 100-year flood plain but would not come under the Flood Plain Act because they were existing before passage of the act. However, any new ponds should meet these requirements.

Any discharge of wastewaters by H-W through the combination of effluent disposal practices will be considerably below 0.5 mg/l after mixing with the river. The maximum actual direct discharges would be limited by the allowable color increase (5 units) after deducting the flow needed to dilute color by seepage. Also, it is proposed to limit the direct discharge to the period of October 1 to July 15. Direct discharge would be prohibited during the period July 15 to October 1 when river water temperatures are at their highest. Using U.S.G.S. water year 1937 (2,582 cfs average discharge), which is the lowest water year on record for the U.S.G.S. station below Missoula, a direct discharge averaging 10 cfs could be permitted for the 288-day period. With a daily average waste flow of 21.6 mgd, this would leave 6.0 billion gallons to be disposed of by rapid infiltration during the year. Assuming a 10-year 7-day low flow of 930 cfs, 85 percent color removal by infiltration and flow through the groundwater and rapid infiltration to occur at a uniform rate throughout the year, the maximum increase of color due to seepage would be less than four units. A storage volume of about 3,600 acre-feet would be required with this system.

Using the proposed in-plant changes and waste disposal practices, the existing discharge following biological treatment and discharge concentrations following plant expansion reaching the river are projected below. For compara-

tive purposes, one-third direct discharge and two-thirds seepage are utilized:

Parameter (pounds per day except flow)	Existing Mill	Existing mill with Biological Treatment and APS	Expanded Mill
BOD	18,500	800	2,100
TSS	5,300	1,100	1,700
Total dissolved solids	300,000	350,000	340,000
Color	171,000	80,000	73,000
Sodium	68,000	66,000	51,000
Chlorides	38,000	49,000	55,000
Sulfates	10,000	60,000	60,000
Phenols	17	6	8
Phosphorus as P	26	43	67
Nitrogen as N	560	280	440
Flow - mgd	15.8	21.6	21.6

The BOD, TSS, phosphorus and nitrogen values were calculated using effluent concentration values presented by H-W consultants. Flow values of 24.8 mgd were utilized in these calculations which should make these projected values conservative when utilizing a flow of 21.6 mgd. The new flow of 21.6 mgd was presented by H-W after the original calculations for the aeration basin were made.

The calculations are based on the assumption that after installation of the biological treatment system, the soluble phosphorus (P) and nitrogen (N) concentrations will be 0.3 mg/l and 2 mg/l, respectively. Also, the TSS in the direct discharge contributes P and N in the ratios of 100 pounds BOD to 5 pounds N to 1 pound P and that 1 mg/l TSS contributes 0.3 mg/l BOD. It is further assumed that there will be no reduction of soluble N and P due to seepage.

Sodium levels will decrease with the expanded mill because of reduction in sodium losses. Chlorides will increase with substitution of the APS system in bleaching. Sulfates will increase with installation of aeration basins as anaerobic decomposition of sulfates which presently occurs should be considerably

inhibited. A reduction of sulfates per ton will also occur with reduction of sodium losses.

It should be noted that the proposed APS system will probably be installed within a year although the exact date has not yet been established.

With regard to alternate treatment systems, H-W says: (February 26, 1974)

With the installation of secondary treatment, the disposal of the effluent from the present or expanded mill will meet all water quality criteria, with the possible exception of color during low-flow years. Rapid infiltration, combined with the new APS bleaching system, should allow the expanded mill to also meet the color standard.

Other systems of color removal have been operative for short periods of time at other Kraft mills in the United States. The treatment system commonly used involves lime addition to the highly colored portion of the effluent.

The advantage of a color removal system by lime addition, presently in use by a few companies, is that color reduction may be sufficient for year-round discharge of water, with the possible exception of extremely low stream flows.

Disadvantages of this system applied to the H-W situation are as follows:

1. It is costly. An EPA report on Kraft pulp mills indicate that operating costs on a plant producing 197,000 tons per year of unbleached pulp increase \$1.47/ton of pulp produced for yearly operation, while total costs equal \$1.95/ton of pulp. This information does not directly apply to the H-W plant at Missoula, because bleached pulp is also produced, and this production creates much more color in the effluent than unbleached pulp requiring perhaps greater costs. However, some recovery of lime from this process has been accomplished at other mills, which lowers the final costs.
2. The state of this technology is in its infancy and its feasibility has not been thoroughly established. Further investigation by H-W beyond the data available from the EPA has revealed several problems with lime treatment. The Interstate Paper Company installation in Riceboro, Georgia, does not recover the lime used for color removal. The massive lime process which was trialed at the International Paper Company mill, Springhill, Louisiana created operating problems in the recausticizing department when the lime was reintroduced back into the process. According to report, the lime system at the Continental Can mill in Hodge, Louisiana is the best full-scale color removal system operating today. However, there are reports of operating problems in recovering the lime.

3. Increased uses of limited resources will be required. In addition to lime, electrical energy consumption will be increased. Again, at the Interstate Paper Company, there was an additional expenditure of 14,000 dollars annually for electricity to operate the color removal system. This must be considered in light of the present energy shortage.

Other color removal systems, such as ion exchange, carbon adsorption, and ozone treatment, are effective in the laboratory or pilot plant basis, but no full scale operations have been established. Several of these systems appear promising, and may provide systems of color removal superior to lime treatment.

In short, the development of color removal technology is proceeding rapidly. Besides effluent treatment systems, in-plant procedures, such as the APS bleaching sequence, are being developed, to reduce the generation of colored effluents. Rapid infiltration, combined with in-plant improvements, should allow H-W to meet the color standard without the large commitment of resources that would be required to install and operate presently available color removal systems. However, should the present approach of rapid infiltration, APS bleaching and other in-plant improvements indicate that this system will not allow the color standard to be met, further steps will be taken, up to and including color removal from selected effluent streams, so that the expanded mill will meet the color standard.

The amount of energy mentioned in the H-W statement above would be a small percentage of the total energy utilized by them. Use of lime treatment in addition to the biological treatment would probably allow H-W to operate without the seepage system. However, with the exception of color, the combination biological-rapid infiltration system should provide greater protection to the stream. Of course, a combined lime-biological-rapid infiltration system would provide a more effective system than that proposed.

III. EXISTING ENVIRONMENT

A. Air Quality

PHYSICAL SETTING

H-W lies west of the Continental Divide within the Missoula Valley. The valley floor runs roughly northwest to southeast with elevations ranging around 3000-3200 feet above sea level. Wooded mountains surround the valley. Most of the 58,300 residents of Missoula County live within the Missoula Valley itself. Missoula's population was approximately 44,000 at the 1970 census.

CLIMATOLOGY (5)

Missoula is situated in the Montana Rocky Mountains in the extreme north portion of the Bitterroot Valley, and about 5 miles east of the confluence of the Bitterroot and Clark Fork Rivers. The Clark Fork Valley extends about 20 miles west-northwestward from Missoula. The Bitterroot Valley runs southward about 70 miles from Missoula.

The Continental Divide is 60 to 80 miles east of Missoula, and the Bitterroot Range is only about 20 miles away to the southwest. These two mountain ranges have a marked effect on the climate of Missoula.

The prevailing flow of air aloft over western Montana is from the west and southwest during spring and summer months, and from the west and northwest during the winter months. Since this air must pass over the Bitterroot Range, it loses much of its moisture on the western slopes of these mountains. As a result, Missoula receives an annual average between 12 and 15 inches of precipitation. This small amount of precipitation leads to a semiarid climate. The heaviest precipitation is received during May and June, with average rainfall of about 2 inches in each of these months.

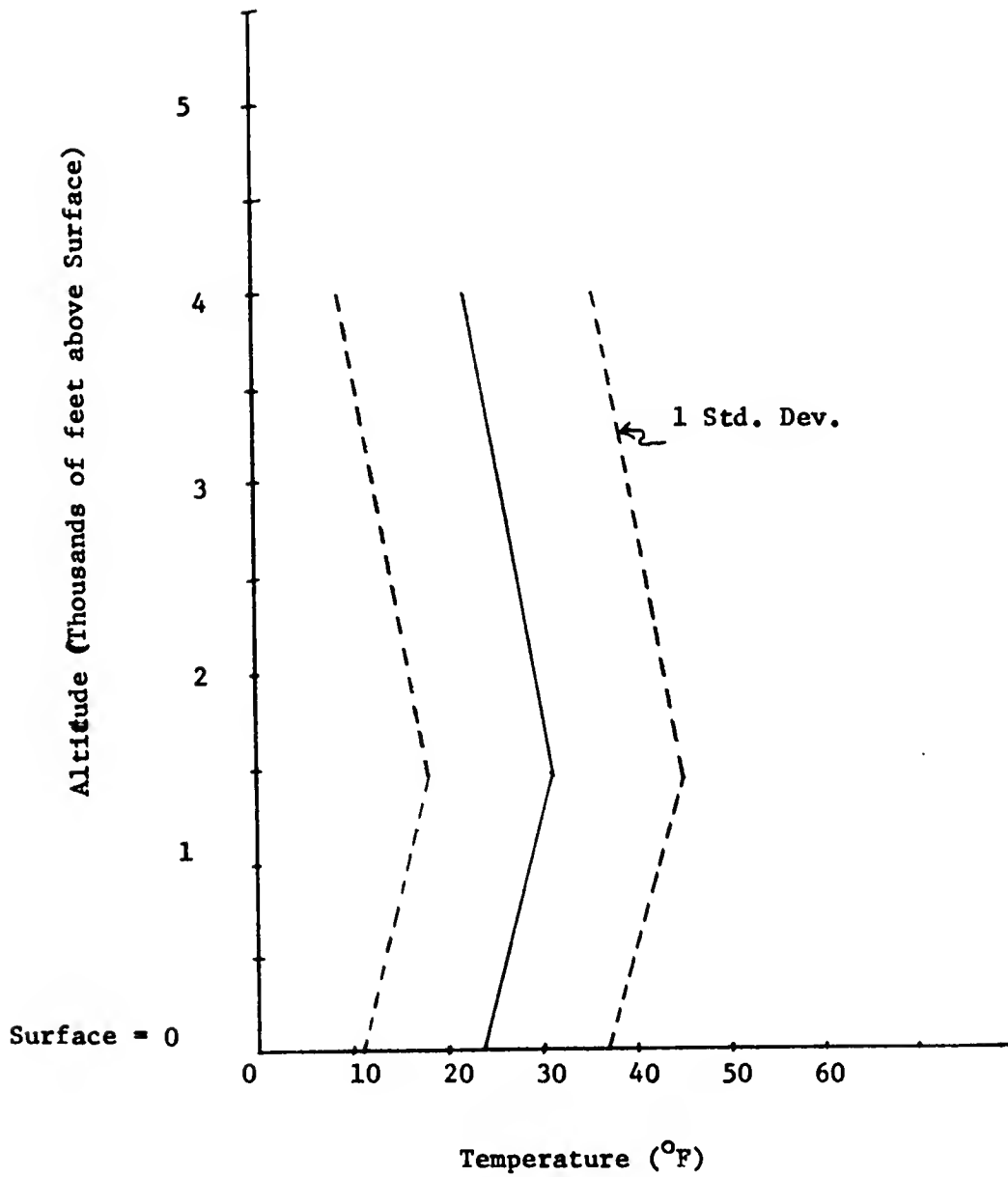
Generally the spring months are cool and a little damp, with almost daily shower activity during May and June. The last spring freeze normally occurs about the middle of May, and there are about 137 growing days each year between the last spring freeze and the first fall freeze. The summer months are dry with moderate temperatures and cool nights. Seldom does the temperature reach 100°. Minimum temperatures during July and August average near 50°.

In the winter, the Continental Divide shields the Missoula area from much of the severely cold air which moves down the continent from arctic regions. Because of this shielding effect, many of the cold waves which sweep down over eastern Montana miss the Missoula area entirely. Under certain conditions, however, the cold arctic air does break over the Continental Divide, and moves with force into the Bitterroot and Clark Fork Valleys. When this happens, Missoula experiences severe blizzard conditions. The cold air is "funnelled" to the city through the Hellgate Canyon of the Clark Fork River. After the valleys of western Montana are filled with the cold air, prolonged cold spells may occur. January is the coldest month, although periods of subzero weather occur occasionally in December and February. There are rare brief periods of subzero weather in November and March.

Data collected from October 1, 1971 through January 31, 1972 by SDHES showed that in the Missoula Valley, the average inversion height was 1500 feet above the valley floor (Figure 4). For areas such as the Missoula Valley where the area is surrounded by high mountains, the data that should be used is the mixing height rather than inversion height. Using data collected at the Johnson-Bell Field for mixing heights shows an

Figure 4

Average Missoula Inversion Temperature Profile
Missoula Field
October 1, 1971 through January 31, 1972



average height of 939 feet (Table 6). Values are as low as 350 feet for the period of December 5, 1973 through February 12, 1974. Wind directions during these periods are characterized by light easterly winds at night and in the mornings and by light west-northwesterly winds in the afternoon. Table shows the average wind speed and percent of time wind blows from the WNW and ESE for the months October-February at Johnson-Bell Field. Table 7 also shows the percent of the hours that are calm and the average temperature. The percentages of wind direction are fairly evenly divided between the two categories. The average wind speed during these periods is about 6 mph or 3 m/sec.

Wind data for Johnson-Bell Field for the entire year shows the prevailing wind as NW to W (Figure 5). The wind rose also shows a high percentage of calms. Comparing this wind data with the data collected at Rock Creek South Wind station (Figure 6) operated by the SDHES Air Quality Bureau (AQB) for the period of May through November, 1973, shows a close similarity. There is a slight shift to the W from the Rock Creek South station to the Johnson-Bell Field. This shift could be due to the nearness to the Rock Creek Canyon to the north of the station. The shift would be reflecting local up canyon day winds and down canyon night drainage winds. The wind data still shows the wind direction prevailing is out of the WNW but a strong component is also out of the ESE indicating pollutants from H-W should be traveling to the Rock Creek South station.

Table 6

JOHNSON-BELL FIELD MIXING HEIGHT DATA

Date (73-74)	Time (MDT)	Mixing Heights* (ft)
12/5	0830	1200
12/10	0830	700
12/14	0830	850
12/18	0830	1750
12/19	0830	1200
1/2	0920	500
1/10	0930	1300
1/23	0830	350
2/11	--	640
2/12	--	900

*Height above valley floor

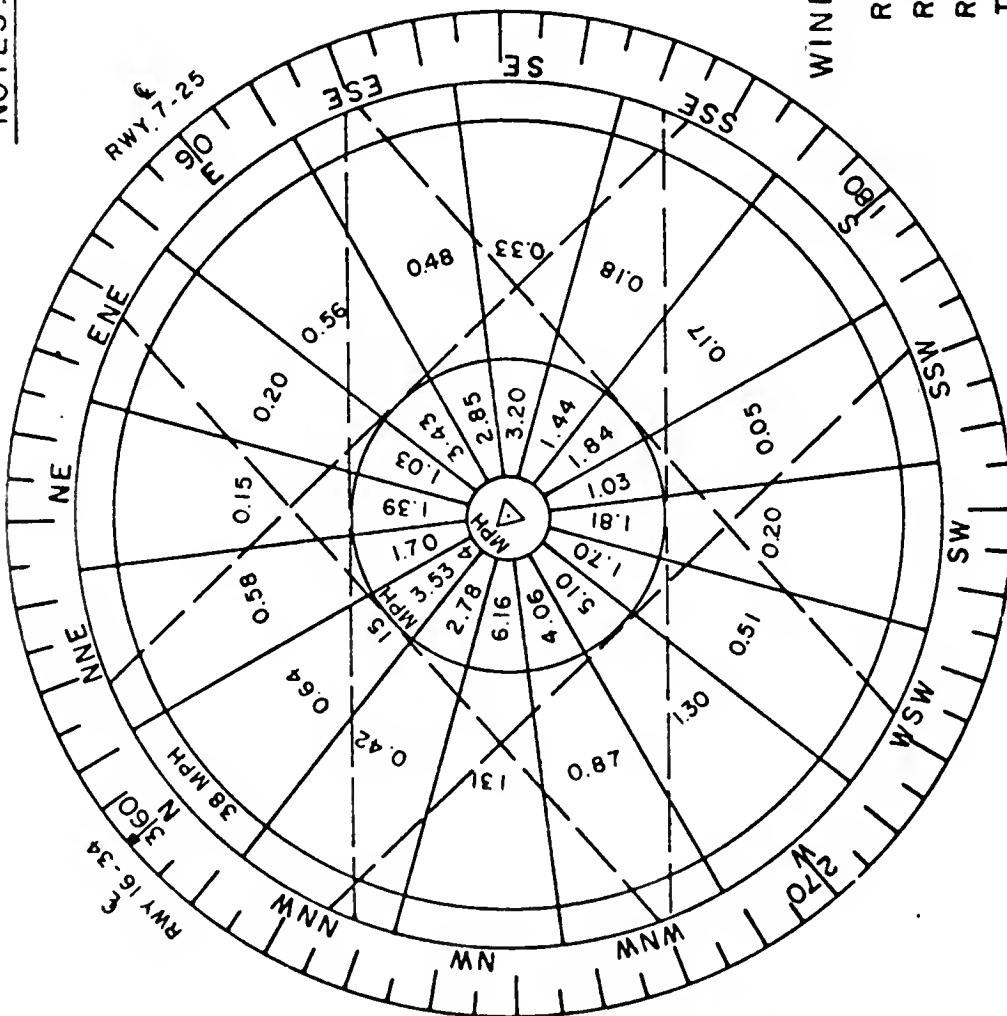
Table 7

WIND DIRECTION, SPEED AND CORRES. TEMP.
Johnson-Bell Field (1949-65)

b	Percent of Total Hours Dir. WNW	Percent of Total Hours Dir. ESE	Aver. Speed (mph)	Calm (%)	Aver. Temp. (°F)
October	26	18	6.6	15	44.6
November	25	21	6.3	16	31.5
December	23	22	5.7	20	25.2
January	21	24	5.1	19	20.1
February	26	21	6.3	13	27.4

NOTES:

1. WIND INFORMATION TAKEN FROM PREVIOUS AIRPORT LAYOUT PLAN DATED AUGUST, 1959. AND REVISED JAN., 1960.
2. COMPILED FROM RECORDS OF THE U.S. WEATHER BUREAU AT MISSOULA COUNTY AIRPORT OVER A PERIOD OF 5 YEARS FROM JAN., 1951 TO DEC., 1955.



WIND COVERAGE

RUNWAY 11-29	96.31 %
RUNWAY 7-25	95.97 %
RUNWAY 16-34	94.43 %
TOTAL	99.46 %

WIND ROSE

Δ = 49.0 % CALMS, 0 - 4 M.P.H.

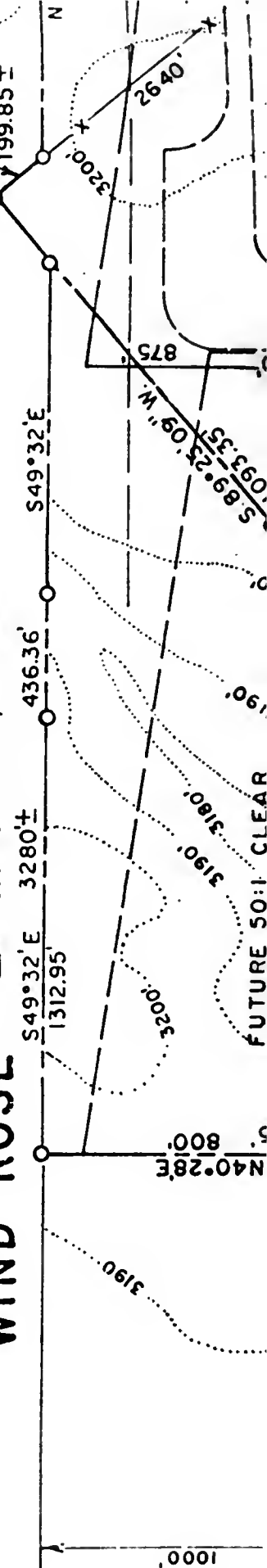
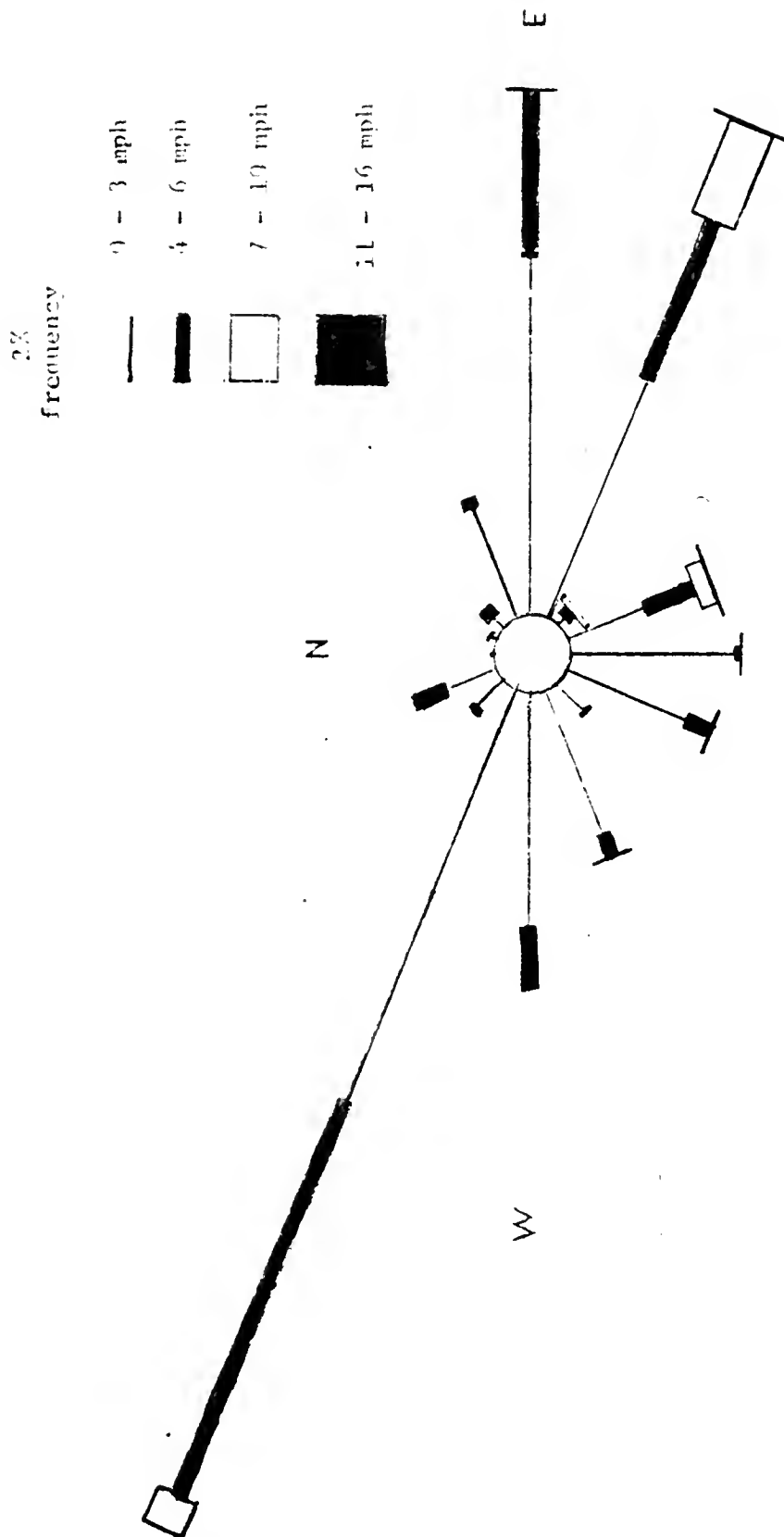


Figure 5



5

These data were collected with an MRI 1072-1 located on a mountain ridge two miles west-northwest of the H-W mill in the Missoula Valley. Results were taken from data collected during the period of May through November, 1973. Data were extracted from charts for one hour intervals.

Wind blows toward the center

Figure 6

AIR QUALITY

When H-W publically announced on August 28, 1973 that it was proposing a plant expansion, SDHES set out to determine what would be necessary for an impact study to assess the proposed expansion. The first thing needed was a characterization of the ambient air within the Missoula Valley.

The Missoula City-County Health Department's ongoing collection of suspended particulates in the air was useful. However, since the manufacturing of pulp and paper causes the emission of hydrogen sulfide and other odorous organic sulfur compounds, it was clear that these too had to be identified and quantified in the Missoula area. It has long been apparent to Missoula residents that there is an odor problem there, caused by odorous emissions from the pulp and paper mill. These odors are at times described as strong, permeating, pungent and putrid. Odor pollution is becoming a major factor in the total air pollution problem in the U.S. Because odor is so easily noticed, complaints about obnoxious odors are frequently received by air pollution control authorities. In the Missoula Valley it is well established that H-W is the source of most of the odor.

The Air Quality Bureau lacked sufficient funds to set up a monitoring system sophisticated enough to characterize the ambient air around the pulp and paper mill. H-W was advised it would be responsible for gathering the necessary air quality information. The bureau designed the network and specified essentially what equipment should be used. H-W, having little experience in air pollution monitoring, contracted with Environmental Science and Engineering of Gainesville, Florida to provide the state with data.

To assure that the information furnished to the state by the company was credible, a quality control program was set up providing guidelines

which both the company and contractor were to follow during the operation of the samplers. Parameters to be monitored were sulfur dioxide, sulfides, total reduced sulfur, merpaptans, disulfides, total suspended particulates and wind information. A copy of the quality control submittal to H-W is contained in Appendix C.

Numerous meetings were held with company and contractor officials to define details relating to this sampling network. The map shown in Figure 7 indicates sampler locations for the initial portion of the year-long sampling contract. Stations were set out to monitor the air where there were population densities, with the exception of the station on the hill west of the pulp mill. During the initial phases of the sampling which began in mid-December 1973, Mr. Roland Samel of the Missoula City-County Health Department visited the stations almost daily in behalf of the City-County Health Department and the Air Quality Bureau.

Data from the sampling done by University of Montana for hydrogen sulfide and sulfur dioxide gives a longer term look at the air quality within the Missoula Valley than is possible with the two months data supplied to the state by the company. Considerable particulate and sulfate data also was collected by the City-County Health Department.

Although wet chemical air pollution monitoring methods are extremely sensitive, they are subject to errors which are unavoidable at low pollutant concentrations as the absorption efficiency is variable and often unpredictable at low concentrations. Interferences and sample loss resulting from aqueous/gas phase reactions and photo/heat decomposition limit the accuracy of wet methods to a range of 10-20 ppb. (6)

New gas chromatography column technology and the flame photometric detector have enabled equipment manufacturers to develop highly specific

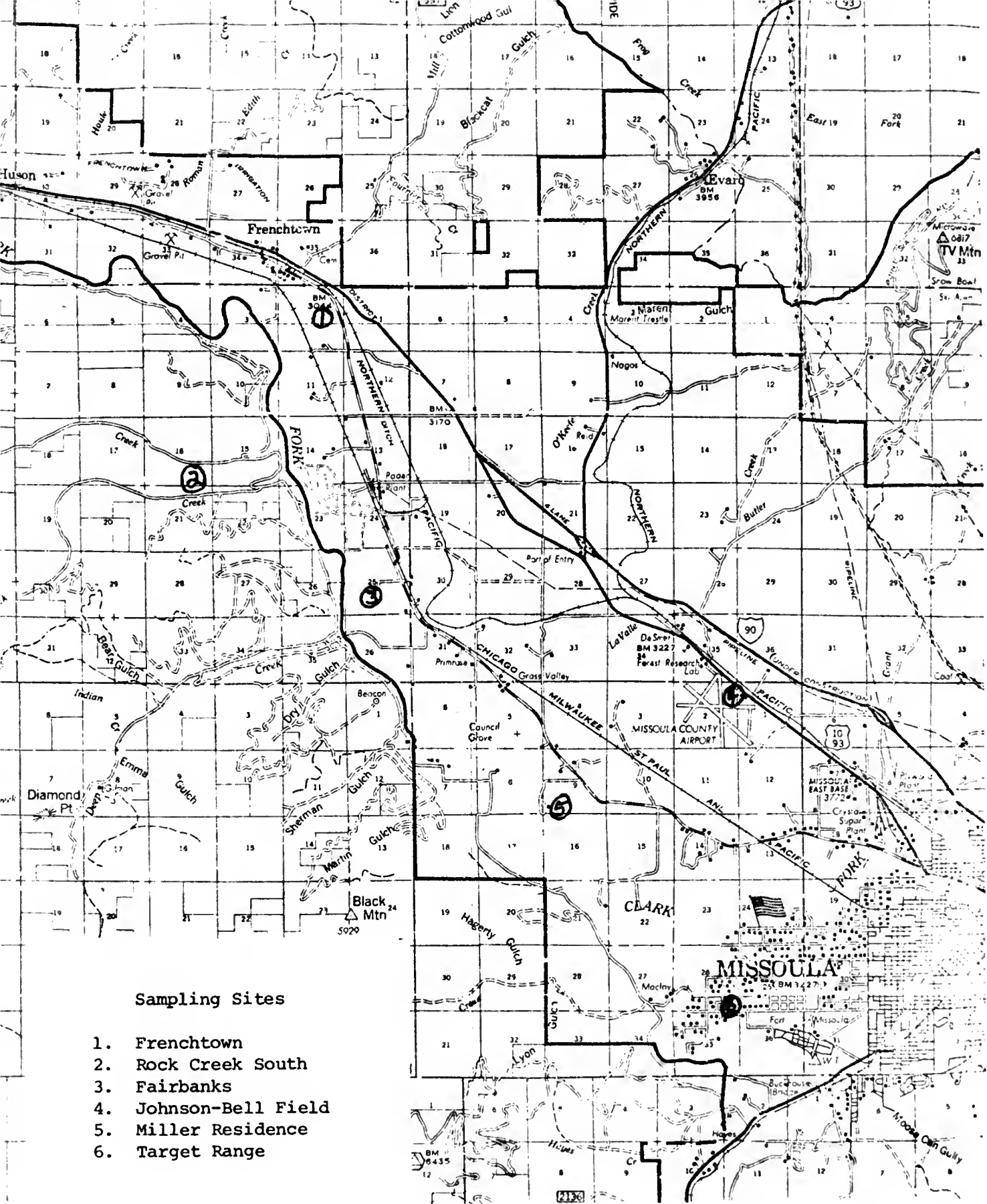


Figure 7 Map showing relative location of the plant and the Air Quality Bureau sampling stations.

sulfur gas analyzers which routinely measure sulfur gas concentrations below 10 ppb. Since the reported odor threshold of a number of reduced sulfur compounds is below 5 ppb and since H-W corporation emits reduced sulfur compounds, it is essential that the most accurately sensitive method be employed in this study.

Odor thresholds have been established approximately as follows for some sulfur compounds believed to be present in the ambient air in Missoula. (7)

Hydrogen sulfide	3 - 5 ppb
Methyl Mercaptan	0.5 - 0.8
Isoprophyl Mercaptan	0.5
Butyl mercaptan	0.5
Dimethyl Disulfide	20
Sulfur Dioxide	300

Since a separation between reduced and oxidized sulfur compounds is required, two gas chromatography (G.C.) sulfur analyzers were purchased by H-W for this study. The Tracor Model 270-HA was selected based on unofficial preliminary evaluations by the EPA and on the successful experience Environmental Science and Engineering personnel have had with Tracor analyzers. The 270-HA provides an analysis of ambient sulfur concentrations once every 225 seconds. The analyzer can be programmed to determine sulfur dioxide, hydrogen sulfide, and total sulfur on automatic mode. A dual pen recorder provides simultaneous output for the 0-100 ppb range and for the 0-1 ppm range to insure that the greatest sensitivity and range is covered.

Tables 8 and 9 contain data collected by the gas chromatographs at the Target Range and Frenchtown locations for a two month period. Dates and running times are given for violations of Montana's hydrogen sulfide regulations.

The regulations are found in Table 10.

TARGET RANGE GAS CHROMATOGRAPH

Period			H ₂ S Concentration PPB		
Date	Begin Time	End Date	No. Viol. in Period	Max. 30 min. Average	Max. Observation per cycle (3 min.)
12-10	1804	12-10	4	40.7	45.7
12-11	0556	12-11	32	89.6	103.4
12-13	0919	12-13	1	34.3	45.7
12-15	1604	12-16	29	79.2	88.2
12-16	0953	12-16	13	46.1	52.4
12-16	0841	12-17	16	83.7	87.3
12-17	0704	12-17	4	91.6	95.9
12-17	1649	12-17	3	47.7	52.4
12-17	2334	12-18	2	35.0	38.4
12-20	2234	12-21	11	99.8	104.9
12-21	1338	12-21	2	50.9	63.0
12-21	1653	12-21	2	34.0	35.5
12-21	1926	12-21	66	59.0	65.9
12-22	0011	12-22	5	57.4	69.7
12-22	0404	12-22	4	56.9	64.9
12-22	0734	12-22	11	47.6	52.1
12-28	2011	12-28	2	34.2	36.0
1-13	0741	1-13	7	42.9	45.3
1-13	1308	1-13	1	44.8	81.6
Total			155	High 99.8	104.9

Table 9

FRENCHTOWN GAS CHROMATOGRAPH

Date	Begin Time	Period and Date	End Time	No. Viola in Period	H ₂ S Concentration PPB	
					Max. 30 minute Average	Max. Observation 3 minute average
12-10	1956	12-10	2056	2	40.8	58.2
12-10	2123	12-10	2253	3	50.2	58.2
12-10	2323	12-10	1823	38	150.2	179.3
2-11	2008	12-11	2134	3	130.5	199.5
12-11	2241	12-11	2311	1	66.8	83.9
12-12	0053	12-12	0149	2	123.7	294.0
12-12	0456	12-12	0623	3	44.0	56.2
12-12	1238	12-12	1619	7	116.2	170.6
12-12	2023	12-12	2123	2	168.8	197.0
12-12	2153	12-12	2349	4	124.1	164.6
12-13	0234	12-13	0334	2	37.7	59.9
12-13	0619	12-13	0649	1	91.8	158.9
12-13	1208	12-13	1334	3	116.8	237.1
12-13	1453	12-13	1523	1	37.4	45.5
12-13	1953	12-13	2053	2	33.3	45.7
12-13	2308	12-13	2338	1	58.3	83.1
12-14	0034	12-14	0104	1	49.5	73.7
12-14	1149	12-14	1219	1	38.5	42.5
12-14	2004	12-14	2026	1	58.6	98.9
12-14	2123	12-15	0223	10	123.3	162.9
12-15	1719	12-15	1749	1	38.1	43.5
12-15	2008	12-15	2208	4	40.1	42.8
12-15	2308	12-15	2338	1	37.9	39.3
12-16	0219	12-16	0249	1	31.4	36.4
12-16	0508	12-16	1838	18	63.2	76.1
12-18	0404	12-18	0434	1	100.7	217.4
12-18	1356	12-18	1556	4	50.5	90.2
12-19	0219	12-19	0919	1	127.3	285.5
12-20	0649	12-20	0919	5	76.3	89.7
12-20	1708	12-20	1738	1	35.8	47.1
12-20	1834	12-20	2104	5	41.8	44.8

Table 9

FRENCHTOWN GAS CHROMATOGRAPH (Cont.)

Period		End Time		No. Viol. in Period	H ₂ S Concentration PPB	
Begin Date	Begin Time	Date	Time		Max. 30 minute Average	Max. Observation 3 minute average
12-21	0423	12-21	0534	2	38.9	44.4
12-21	0749	12-21	1449	14	114.4	189.4
12-21	1534	12-22	0108	19	124.4	141.0
12-22	0149	12-22	1549	28	134.2	168.7
12-22	1919	12-22	2319	8	138.7	191.1
12-23	0119	12-23	0349	5	120.0	135.0
12-24	1319	12-24	1419	2	67.0	75.7
12-26	1319	12-26	1549	5	61.6	74.2
12-26	1623	12-26	1653	1	41.4	49.3
12-28	0841	12-28	0911	1	36.0	52.3
12-29	0419	12-29	0519	2	47.4	60.1
12-29	0749	12-29	0819	1	44.8	54.2
12-29	1308	12-29	1408	2	46.0	73.1
12-29	1556	12-29	1734	3	46.4	51.7
12-29	1919	12-29	1949	1	30.4	32.7
12-31	1904	12-31	2134	5	48.6	64.9
1-1	0034	1-1	0134	2	41.3	51.9
1-1	0149	1-1	0449	6	57.2	71.9
1-1	0538	1-1	0838	6	78.7	115.7
1-1	0941	1-1	1219	5	62.5	67.9
1-1	2123	1-1	2256	3	42.4	50.9
1-4	1938	1-4	2008	1	43.5	52.0
1-13	1519	1-13	1549	1	37.5	43.4
1-14	2049	1-14	2119	1	48.5	61.1
1-14	2226	1-14	2256	1	33.7	64.2
1-15	0256	1-15	0326	1	73.1	137.4
1-15	1749	1-15	1819	1	46.0	113.8
1-16	1211	1-16	1411	4	97.4	119.0
1-16	1749	1-16	1949	4	93.6	123.1
1-17	2041	1-17	2111	1	34.7	41.2
1-19	0053	1-19	0241	3	62.5	123.0
Total 269					Max. 168.8	Max. 294.0

HYDROGEN SULFIDE

Considering first the Target Range station which is 9.67 miles southeast of the pulp and paper mill, several readings were as much as three times the 30-minute allowable level for hydrogen sulfide (H_2S). If 3-5 ppm H_2S represents the odor threshold, then 10 miles from the plant there were ambient levels 20 to 30 times the odor threshold. People in the Target Range area were for 16 hours subjected to H_2S concentrations on December 11, 1973, considerably higher than Montana's regulation allows. For 5.2% of the total two month monitoring period, hydrogen sulfide levels in the area were above 30 ppb. An emission roll-back to meet state air quality standards would require a 70% improvement from the December 20 H_2S concentration. At the Target Range station approximately 69% of the data was recovered for use in this statement. In order to establish validity EPA suggests that 75% of the data collected from continuous monitoring equipment should be recovered. Startup problems were numerous and many operational difficulties arose, but these are documented to the extent that the Air Quality Bureau accepted the data as valid. As indicated in Appendix C, the Bureau checked all readings before they were analyzed by H-W's contractor to insure correct interpretation of data. Some difficulty arose with regard to calibration curves and their relationship to the total data reduction but the company corrected this difficulty before the issuance of this draft statement. On April 10-11 Air Quality Bureau personnel performed a dynamic calibration on the Target Range gas chromatograph and it agreed with the company's calibration.

Doctor Ron Erickson's university group obtained on December 17, 1973, a 30-minute wet chemistry reading of 112 ppb H_2S at 4801 Sundown Road. This is roughly in the Target Range area.

Table 10

APPLICABLE AMBIENT AIR STANDARDS (1) (2)

Contaminant	Standard
Sulfur Dioxide	<p>20 ppb (state), annual arithmetic mean</p> <p>100 ppb (state), 24-hour average not to be exceeded over one percent of the days in any 3 month period.</p> <p>140 ppb (federal), 24-hour average not to be exceeded more than once a year.</p> <p>250 ppb (state), 1-hour average to be exceeded no more than one time in 4 consecutive days.</p> <p>500 ppb (federal), 3-hour average not to be exceeded more than once a year.</p>
Hydrogen Sulfide	<p>30 ppb (state), 30-minute average to be exceeded no more than two times in 5 consecutive days.</p> <p>50 ppb (state), 30-minute average to be exceeded no more than two times annually.</p>
Total Suspended Particulate Matter	<p>60 $\mu\text{g}/\text{m}^3$ (federal secondary) annual geometric mean.</p> <p>75 $\mu\text{g}/\text{m}^3$ (federal primary) annual geometric mean.</p> <p>150 $\mu\text{g}/\text{m}^3$ (federal secondary) maximum 24-hour concentration not to be exceeded more than once a year.</p> <p>200 $\mu\text{g}/\text{m}^3$ (state) to be exceeded no more than three times a year.</p> <p>260 $\mu\text{g}/\text{m}^3$ (federal primary) maximum 24-hour concentration not to be exceeded more than once a year.</p>
Suspended Sulfate	<p>4 $\mu\text{g}/\text{m}^3$ (state) annual arithmetic average.</p> <p>12 $\mu\text{g}/\text{m}^3$ (state) to be exceeded no more than three times a year.</p>

(1) Federal Register, Volume 36, No. 84, Part II, April 30, 1971.

(2) Montana Administrative Code 16-2.14(1)-S14040 Ambient Air Quality Standards.

The University group sampled several areas in and around Missoula in 1973. A 115 ppb H_2S concentration was recorded in mid-July seven miles southeast of the mill. Thus it might be surmised that summertime levels are high even without the increased fall-winter inversion frequency.

At the Frenchtown gas chromatograph H_2S levels were considerably higher and violation readings more numerous than at the Target Range station. The Frenchtown station 2.7 miles NNW of the plant gave a high H_2S 30-minute reading of 168.8 ppb. This value was 5.6 times Montana's regulation level and some 34 to 56 times the odor threshold. On December 10, 1973, the people in the Frenchtown area were subjected to noxious H-W odors for 19 hours of the day. During 9.0% of the two month period H_2S concentrations exceeded Montana's 30 ppb regulation level. The 168.8 ppb H_2S value would call for an 82% reduction to meet state standards.

Some 64% of the data at Frenchtown were recovered. The validity of this data was accepted on the same basis as that from the Target Range station.

In mid-August, 1973, University sampling netted a 209 ppb H_2S reading in the Albert Creek area across from the settling ponds which would necessitate an 86% roll back. This ambient sample was taken considerably closer to the plant than were the samples collected at the Frenchtown station.

Hydrogen sulfide sampling was not performed at the Rock Creek South station, as shown in Figure 7. Diffusion modeling, however, predicted fairly high concentrations there under stable air conditions at present plant emission levels. Even with projected emission reductions as proposed by H-W in its expansion program, H_2S violations on the hill side west of the plant are possible.

SULFUR DIOXIDE

Sulfur dioxide was collected both by the Federal Reference Method (West-Gaeke bubbler) and the gas chromatograph. Collection was made by H-W at stations 1, 2 and 6 on Figure 7. Station 2, the hill station, was selected to monitor for sulfur oxide concentrations sufficient to cause the vegetation damage documented by the U. S. Forest Service (8).

On the gas chromatograph, a 12-second sample was taken during each three minute sampling cycle. Data is presented in Table 11.

Table 11

SULFUR DIOXIDE READINGS

3 minute observations	Frenchtown	Target Range
greater than 25 ppb	21*	218
Approximate total observations	15,000	15,000
High 3-minute observation	49.2 ppb	58.5 ppb
High 30-minute observation	32.3 ppb	42.3 ppb
High 60-minute observation	16.2 ppb	41.8 ppb

*Two of these observations were in question

At Target Range high values occurred on December 15 and 16, 1973, while most of the high Frenchtown readings occurred January 9, 10 and 11, 1974. Missoula weather on December 15 and 16 was cloudy, rainy with wind speeds less than 10 miles an hour, temperatures ranged from 29° to 41° F. On January 9, 10 and 11 the weather service reported snow and winds from calm to 20 knots accompanied by temperatures from -13° to 9° F.

With the January 9-11 weather conditions natural gas curtailment was in effect at the H-W mill. Montana Power Company officials said that for the three days in question H-W was asked to curtail its natural gas useage by at least 50% for 3, 10 and 13 hours on the respective days. Curtailment of natural gas necessitated the use of fuel oil which is higher in sulfur content and generally causes sulfur oxide emissions, which may explain the high readings on those days.

During December and January there were 197 more three-minute observations over 25 ppb at Target Range than there were at Frenchtown.. This implies that there may be other sources of sulfur dioxide aside from the paper mill.

The highest recorded SO₂ value of 58.5 ppb (0.0585 ppm) over a three-minute cycle is much lower than the state one-hour regulation level of 0.25 ppm. No violations of sulfur dioxide standards were recorded during the sampling period. Wintertime brings lower inversion levels and more frequent air stagnation periods. If high sulfur oxide concentrations were ever present it is probable they would have been detected during the winter sampling period.

On the hill west of the pulp mill, the H-W information was of questionable value. Wind recordings made at that site, #2 on Figure 7, indicate that the sulfur dioxide bubbler results did not correlate with wind information. The highest reading (50 ppb SO₂) was recorded at a time when winds were in general from the NW. East winds are necessary if H-W emissions are to be sensed at the hillside monitoring station.

An April 10, 1974 visit to the sampling site indicated that the SO₂ bubbler system had a bad air leakage--instead of a one liter per minute flow the flow was recorded to be 0.13 liters per minute. It appeared that air within the metal shelter was being sampled rather than the outdoor ambient air. Other instrumental problems and poor sample handling procedures were noted. Whether these problems were indicative of the equipment operation for the total sampling period is not definitely known even though an instrumentation log book was maintained. In general, the AQB does not find the SO₂ bubbler information at the hill location to be valid.

Station #2 is located some 800 feet higher than the floor of the valley near the plant. Sulfation rate sampling was carried out by the U. S. Forest Service in conjunction with the State of Montana at various locations on the hillside generally west of the mill. Several sites at locations lower than station #2 recorded violation levels of Montana's reactive sulfur (sulfation) regulation. These sulfation plates are exposed for approximately one month in the field before they are chemically analyzed. An exposure period in July and August, 1973, gave a result of 0.9 mg SO₃/100 cm²/day where the maximum standard for any one month period is 0.50 mg SO₃/100 cm²/day. November-December and January-February composite samples gave respective sulfation rate values of 0.065 and 0.03 mg SO₃/100 cm²/day at the hill station #2. Winter monitoring gave no violations of sulfur dioxide or sulfation rate standards. During the summer of 1973 there were several violations of the sulfation regulation.

Vegetation sampling conducted both by the U. S. Forest Service and the AQB gave increased sulfur concentration with decreased distance from the mill.

METHYL MERCAPTAN

Methyl mercaptan levels were extrapolated from chromatograph charts as being the difference between the peaks representing total reduced sulfur levels and the peak measuring the combination of sulfur dioxide and hydrogen sulfide. Table 12 shows methyl mercaptan concentrations. Some of the values are doubtful, as the company experienced many instrumental problems during instrument startup. Mercaptans are considered important since their odor threshold is some 10-20 times lower than that of hydrogen sulfide.

Table 12

Frenchtown methyl mercaptans (MeSH)

Date	No. observations above 15 ppb	High 3-min Observation	High 30-min Observation	High 60-min Observation
Dec. 11	18	39.9 ppb	26.3 ppb	19.0 ppb
Dec. 12	24	49.4	24.4	18.9
Dec. 13	9	47.5	19.6	9.8
Dec. 18	5	45.7	9.7	4.8
Dec. 19	3*	145.7	64.4	32.2
Dec. 21	17	30.0	21.8	8.1
Dec. 22	42	35.0	26.3	16.7
Dec. 23	6	22.3	17.1	10.2
Dec. 28	7*	32.9	26.9	15.3
Dec. 29	1*	36.8	--	--
Dec. 30	1*	73.7	--	--
Jan. 1	1	19.7	--	--
Jan. 10	1*	26.1	--	--
Jan. 14	2*	77.7	--	--
Jan. 15	3	32.1	13.7	6.9
Jan. 16	10	33.1	24.1	20.9
Jan. 18	1*	23.0	--	--
Jan. 19	5	28.7	15.6	7.8
Jan. 24	1	17.4	--	--
TOTAL	157	145.7	64.4	32.2

Target Range methyl mercaptans

Dec. 10	1*	17.9	--	--
Dec. 16	17*	54.5	21.7	14.4
Dec. 17	10*	24.9	18.2	13.0
Dec. 26	1*	26.3	--	--
Jan. 8	1*	21.6	--	--
Jan. 9	3*	35.5	--	--
Jan. 10	3*	58.0	22.7	11.4
Jan. 21	2*	31.3	10.3	5.1
Jan. 22	2*	42.0	14.0	7.0
TOTAL	40	58.0	22.7	14.4

*Doubtful data - all other MESH readings had high H₂S readings in equivalent time periods.

SUSPENDED SULFATES

The Montana ambient air quality standard for suspended sulfate is 4 micrograms per cubic meter of air, as a maximum allowable annual average, and 12 micrograms per cubic meter of air, not to be exceeded over 1 per cent of the time.

Table 13 shows that arithmetic mean concentration of suspended sulfates at the Missoula County Courthouse for 1973 was 3.5 ug/m^3 which is approaching the Montana standard for suspended sulfates. The courthouse had ten days exceeding 12 ug/m^3 . The high reading was 19.3 ug/m^3 . Seven days exceeded the one percent of the time state standard.

So far in 1974 the Missoula County Courthouse has had two days exceeding 12 ug/m^3 . Table shows that suspended sulfate concentrations are lower at Johnson Bell Field than at the courthouse in Missoula. Observations made by AQB personnel from the ground and the air indicate that H-W emissions generally follow the sides of the valley as they drift toward Missoula rather than drifting toward the air field through the valley center which would account for lower sulfate concentrations at Johnson Bell Field.

Urban centers such as Missoula are known to have some sulfate concentrations even without specific sources such as the pulp and paper mill.

Sulfates recorded by H-W at Target Range, Frenchtown and the hill station, #2 are shown below in Table 14.

Table 14

SUSPENDED SULFATES AS COLLECTED BY THE COMPANY

Station	Number of Observations	High Value (ug/m^3)	Two month's plus Average (ug/m^3)
Target Range	39	10.8	0.94
Frenchtown	40	9.8	1.07
Hill Station	25	4.3	1.64

Table 13
Suspended Sulfates
Information Gathered by Missoula City-County Health Department

Month	COURTHOUSE		JOHNSON BELL FIELD	
	Month's Avg.	High for Month	Month's Avg.	High for Month
March, 1974	6.8 ug/m ³	10.2 ug/m ³	**	**
Feb.	4.7	12.4(2)*	4.1*	10.3*
Jan., 1974	2.7	7.3	3.7	9.5
Dec., 1973	4.5	13.5(2)	3.4	14.0
Nov.	3.3	6.5	3.5	**
Oct.	4.7	7.3	3.6	**
Sept.	2.1	3.8	2.1	**
Aug.	3.1	4.8	2.0	**
July	2.8	5.0	2.5	**
June	2.1	4.6	1.9	**
May	2.8	6.4	2.4	**
Apr.	3.1	9.3	3.1	**
Mar.	2.0	4.5	**	**
Feb.	6.6	19.3(6)	**	**
Jan., 1973	4.6	14.1(2)	**	**

*number in parentheses gives the total values over 12 ug/m³ for the courthouse location only.

1973 Annual average for courthouse was 3.5 ug/m³ suspended sulfates.

1973-74 Eleven month annual average at Johnson Bell Field was 2.9 ug/m³.

1973-74 Eleven month annual average at Courthouse was 3.3 ug/m³.

**not available

ug/m³ is micrograms of sulfate per cubic meter of air sampled.

A trend is evident in the table. Noting that the hill station is closest to the plant and Target Range farthest, it is clear that average sulfate concentrations increase as one approaches the plant.

The 1966-1967 sulfate average for a non-urban Glacier National Park station was 1.2 ug/m^3 (9). It seems unusual that winter time particulate sulfate values as collected in the Missoula area by H-W should be lower than those collected at a remote sampling site considerably removed from a source of sulfates.

According to data supplied the state by H-W in March, 1974 ("An Evaluation of Missoula Valley Air Quality Data") an ambient temperature of 70°F was assumed for Missoula for December and January. With this assumption there could be an approximate 12% negative error in the particulate and sulfate data collected by the company. The AQB noted also that the sampling shelters used by H-W were not constructed according to the high-volume sampler reference method. This difference in the H-W shelters makes it difficult to compare H-W data with data from samplers in properly constructed shelters.

It appears that the company's sulfate and particulate data would more closely correlate with Missoula City-County Health Department data if proper corrections were made. The company probably would have recorded a value over 12 ug/m^3 at Target Range. Both suspended sulfates and total suspended particulate were collected in the high-volume samplers.

The AQB and City-County Health Department ran particle sizing monitors, total suspended particulate (high-volume) samplers and a membrane sampler during April, 1974 at locations shown in Figure 7 and indicated below in Table 15.

Table 15

SHORT-TERM PARTICULATE MONITORING

Station	Type Sampler	Location in Figure
Fairbanks	A,B,C,D,	#3
Johnson-Bell Field	A,C,	#4
Miller Residence	A	#5
Target Range	A,B,C,D	#6

A - high-volume sampler (total suspended particulates)

B - membrane sampler (chemical analysis of particulates)

C - cascade particle sizing sampler (particle sizing and chem. analysis)

D - wind instrument

Insufficient data was collected during the initial phase of this sampling to give good trend information and the company's contractor, Environmental Science and Engineering, has not sent the AQB its chemical analysis methods for sodium and sulfate analysis even though it has on several occasions promised to send it. Consequently the membrane filters have not yet been analyzed for sodium. The AQB has made an effort to correlate data with the company, therefore, the bureau must know the methods used.

Primarily samples were taken to check suspended sulfate levels and particle sizes in relation to distance from the mill. Since Environmental Science and Engineering said it was having difficulty obtaining sufficient samples for sulfate analysis, AQB ran equipment for some 72 hours for each sample. Excepting one total suspended particulate value of 320 ug/m^3 on April 22, 1974 at the Fairbanks location, 1.4 miles due south of the plant, all suspended particulate data readings were 50 ug/m^3 or less.

The highest suspended sulfate level of 3.63 ug/m^3 was obtained at the Fairbanks residence. Twelve composite samples were run generating the equivalent of 36 days data. Correlation between sulfates obtained on the fiberglass filters (high-volume sampler) and the cellulose filters (membrane samplers) was good with the membranes producing slightly higher readings.

Particle sizing information gave perhaps the most interesting information. The state found that the mean mass diameter (MMD) of particulate matter in the air decreased as the plant was approached from the southeast. Larger particles are found in the Target Range area and smaller particles near the plant as shown below.

MMD (microns)	Site
3.2	Target Range
2.5	Johnson Bell Field
2.2	Fairbanks

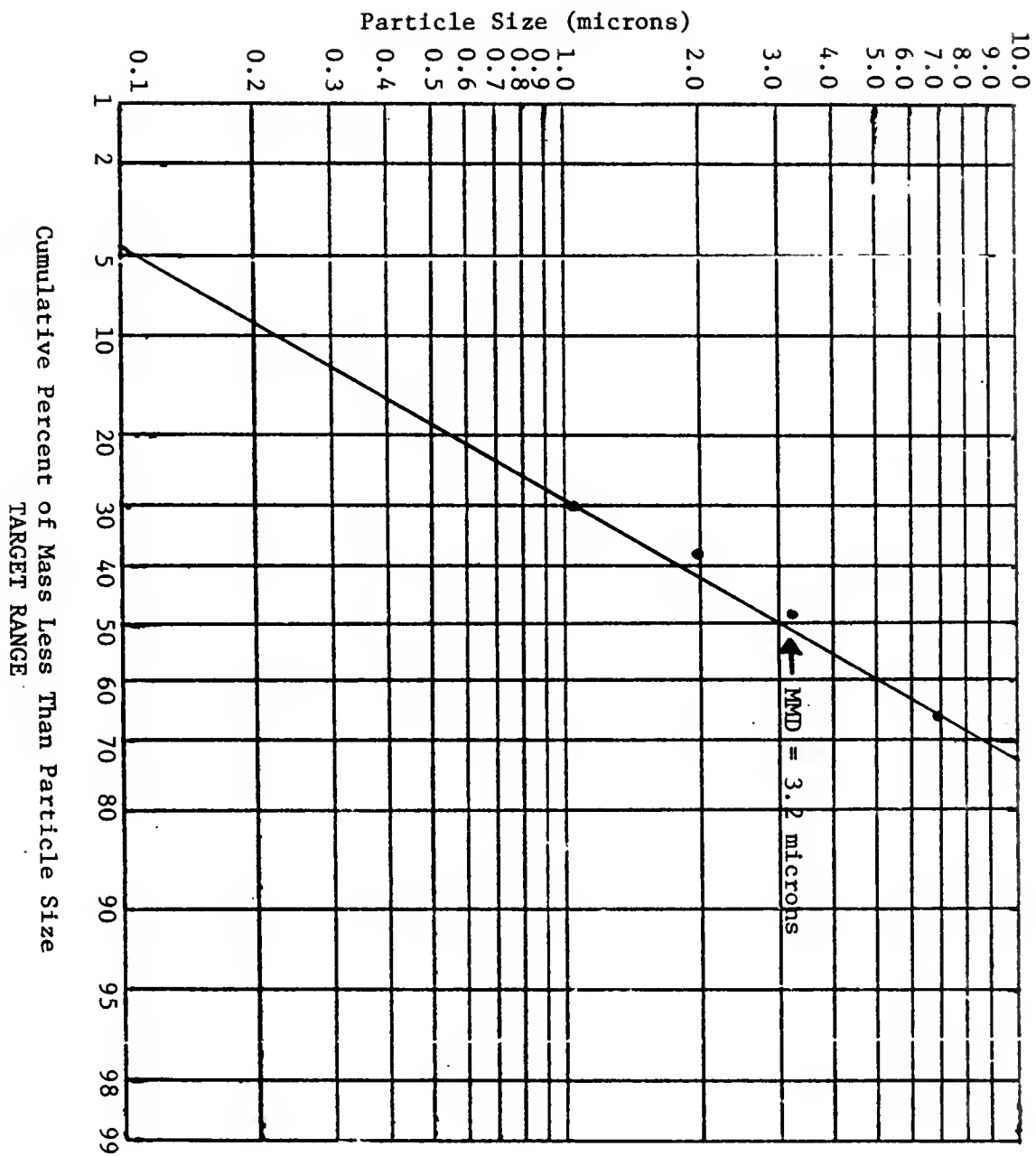
Sulfate analysis of the different particles sizes gave the following information for the Fairbanks location April 17-24, 1974.

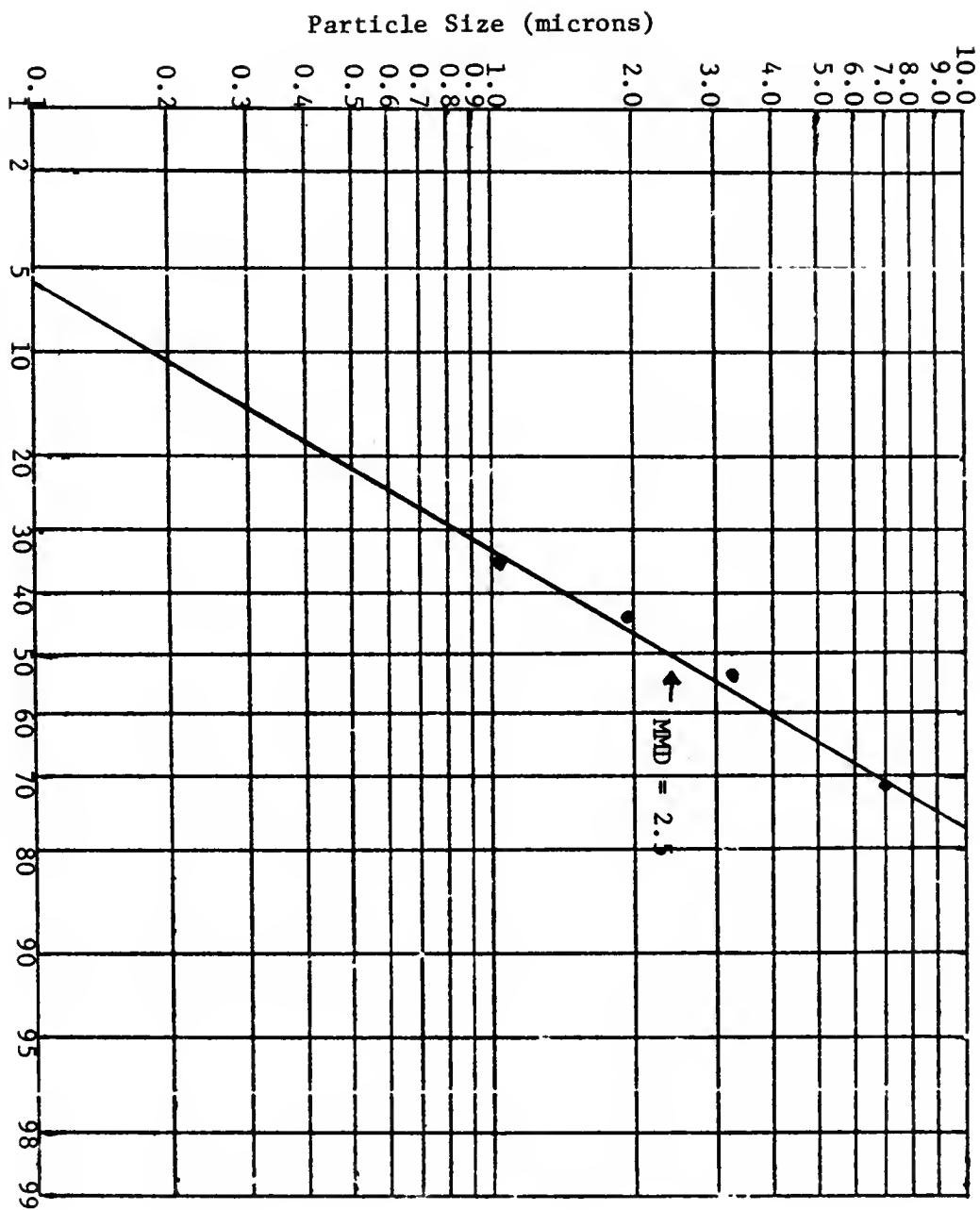
	Particle Size	Sulfate Concentration
Stage 1	7.0 microns plus	0.31 ug/m ³
Stage 2	7.0 - 3.3	0.23
Stage 3	3.3 - 2.0 u	0.27
Stage 4	2.0 - 1.1 u	0.39
Stage 5	Submicron	2.43

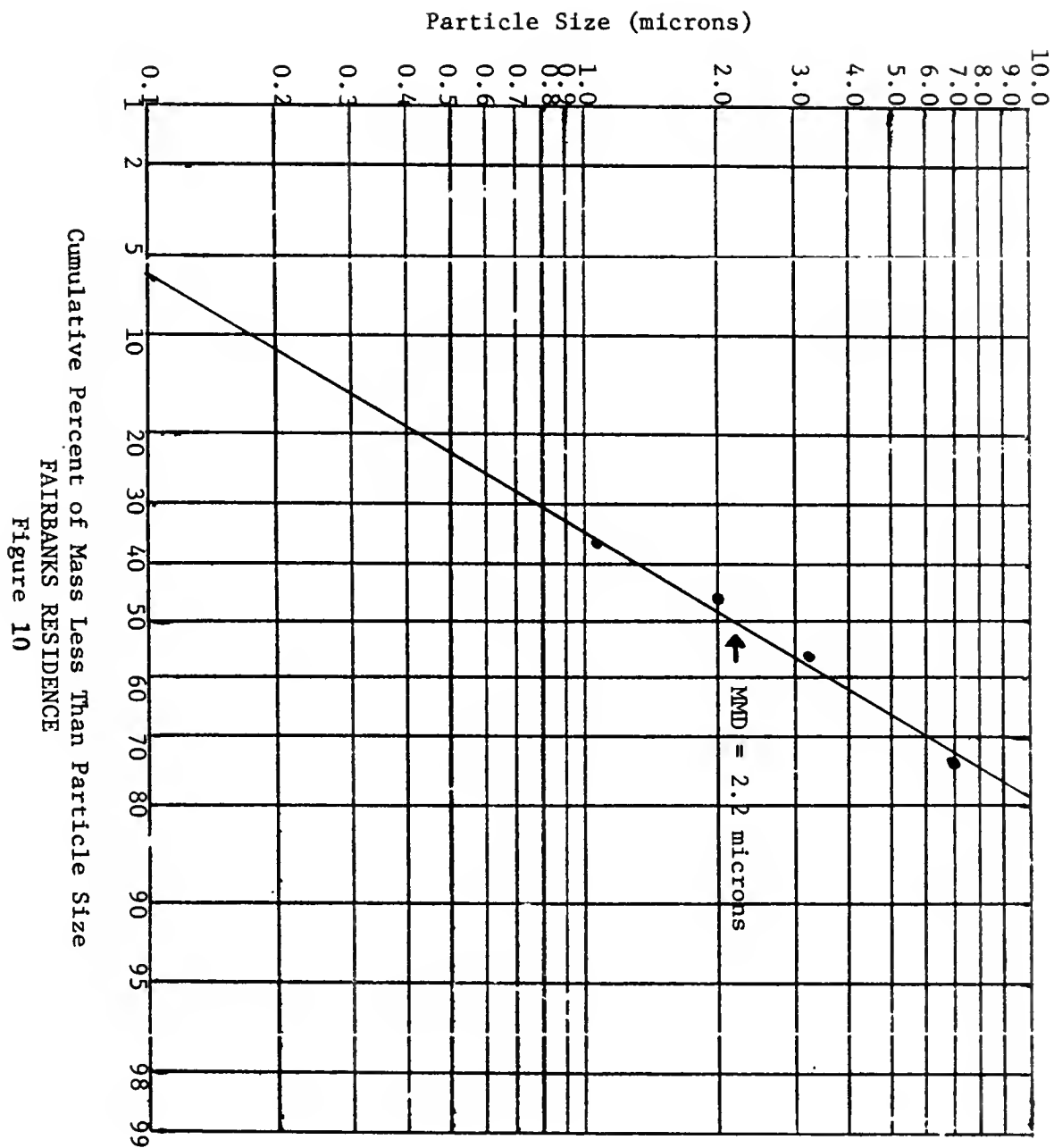
u is the symbol for a micron (a unit of length equal to one millionth of a meter (39.37"))

The data show that most of the particulates are very small near the pulp-paper mill and that the sulfate concentration increases as the size of the particle decreases in size. Figures 8, 9 and 10 depict composite data for the three cascade impactor monitoring sites during April of 1974. Some 30-35% of the particles are one micron or smaller in size. This is the size range which leads to respiratory problems since these small particles can penetrate into the lungs.

In summary, the airborne sulfate data collected by the company seems to bear some inherent errors as the data was supplied to the state.







It must be pointed out that the average sulfate concentrations as recorded by the Missoula City-County Health Department and the state are in general low but that high short-term values are recorded.

High sulfate concentrations in the very small particles in the Missoula Valley could be a potent health hazard.

PARTICULATES

The Missoula Valley is included within the Montana Air Quality Control Region which is required by the State Implementation Plan to enforce stringent airborne particulate control. A history of high recorded total suspended particulate values in the area led to this stringent classification.

Table 16 shows a trend for the Missoula Valley.

Table 16

COMPARISON OF TOTAL SUSPENDED PARTICULATE LEVELS IN MISSOULA (values in micrograms per cubic meter)

Year	No. of Samples	Arithmetic Average	Max. 24-hour Average
1961-62	115	158	666
1971-72	362	86	269
1972-73	360	76	261
1973-74	270	80	914
1971-74	992	81	914

The 1961-62 data were obtained at the Federal Building in Missoula and the 1971-74 data all comes from monitoring equipment on the courthouse. The two locations are reasonably close together in downtown Missoula. The annual averages were used for comparison since the early data couldn't be converted to geometric averages as the standards require. The change downward from 1962 to 1971 was due mainly to the removal of tepee burners from Missoula lumber mill operations, but it is important to note that

present particulate emissions in downtown Missoula are close to federal primary standards (75 ug/m³ annual geometric average). An 81 ug/m³ arithmetic average roughly equals 73-75 ug/m³ geometric average.

Numerous concentrations above the 24-hour federal and state standards have been observed within the valley.

How much does H-W contribute to the Missoula particulate level?

Would the plant expansion add to the particulates in Missoula?

During the November - January sampling in the valley the following values were obtained as in Table 17,

Table 17

TOTAL SUSPENDED PARTICULATE DATA NOVEMBER, 1973 - JANUARY, 1974
(Micrograms per cubic meter of air)

	Geometric Average	Calculated Max. 24-hr. value
Target Range (HW)	43	200
Target Range (MC)	23	**
Johnson Bell Field (MC)	31	**
Frenchtown (HW)	42	133
Hill Station (HW)	19	93

HW - Hoerner Waldorf

MC - Missoula City-County Health Department

** - calculation not applied

As noted in the previous section on suspended sulfates the particulate data collected by the company appears to be approximately 12% below the actual concentrations. Inasmuch as winter particulate concentrations are generally the lowest values for the year due to snowy-damp weather, it is difficult to speculate on year round total suspended particulate values without the availability of further sampling data.

Other than one reading (320 ug/m^3 - 24-hr. average) obtained at the Fairbanks Residence, 1.4 miles south of the plant by the state on April 22, 1974, no violation of the particulate standard has been observed in the vicinity of the plant.

VISIBILITY

Considerable impairment of long range visibility has been observed in the Missoula Valley. Many days during the year the mountains surrounding Frenchtown are obscured from the view of people in Missoula. Sometimes the opposite is true and the Missoula end of the Valley is obscured.

This impaired visibility is probably not measurable in economic terms, but it is an unpleasant reminder of H-W's pollution of the air. Most residents of the scenic Missoula area probably would not agree that they should unnecessarily sacrifice their view for H-W's benefit.

Particulate matter in the size range of 2 microns and smaller comprise 45% of the particulates in the Missoula air. Considering that particles 0.02 to 2 microns account for most of the visibility reduction (10), it is obvious that Missoula has particulate problems.

On April 17, 1974 readings were made in the Missoula Valley with an airborne nephelometer. The nephelometer was used to measure the light scattering that morning. Table B gives data which show the visibility to be reduced to 11.5 miles in H-W area. It was noted later that the instrument has been operated on a less sensitive range than should have been used. Consequently the reduction of vision in miles are probably worse than measured.

Evans products and Van Evans both contribute some to the visibility reduction in the Missoula area, but visual observation and instrument readings indicated that H-W was primarily responsible for the poor visibility in the Valley on April 17, 1974.

Table 18

NEPHELOMETER DATA FOR MISSOULA VALLEY 4/17/74

Area	Scattering Coef. (M ⁻¹)	Visibility (miles)	Number of Readings
H-W Plume	28.6 x 10 ⁻³	11.5	8
H-W Ponds	22.6 x 10 ⁻³	14.3	5
Van Evans Plume	22.5 x 10 ⁻³	13.0	3
Evans Products Plume	2.15 x 10 ⁻³	15.0	1
Frenchtown Haze Layer	27.1 x 10 ⁻³	11.8	4
Mill Creek Area	15.7 x 10 ⁻³	21.4	7
NE Side of Valley (Foothills)	13.6 x 10 ⁻³	26.0	17
Missoula	12.2 x 10 ⁻³	30.6	9
Airport	14.0 x 10 ⁻³	24.6	3

Even though most of the visible plume from the plant is steam, considerable amounts of particulate were seen coming from the mill. An indication of equivalent particulate mass loadings was also given by the nephelometer which indicated a very high concentration of very small particles over the plant and out from the plant for several miles.

At higher altitudes it was impossible to see the valley floor due to plant emissions. It appears that pilots could experience great difficulty in landing in the valley.

BARTON TITRATOR CALIBRATIONS

All the emission data in this impact statement was furnished by the company. To check the validity of the data, a team from the AQB performed a series of tests on the efficiency of the Barton Titrators used by H-W to monitor emissions.

The first step in the testing was injecting known amounts of H_2S and SO_2 into the monitor, then noting the readings on the recorder trace. Next, the same concentrations were injected into the sample lines where they attached to the stacks, and the recorder trace again was noted. These tests disclosed several problems with the test system. First, it was noted that some of the sample lines were over 100 feet long, had places where moisture from stack emissions could collect and partially scrub out the gases being monitored. Also, several leaks were found in the sample lines. Table 19 contains the data collected in the testing.

Table 19

EFFICIENCY OF H-W BARTON TITRATORS April 19, 1974

Barton Titrators	Efficiency
Recovery Boiler #3	
H_2S	81.5%
SO_2	84.6%
Recovery Boiler #4	
H_2S	91.7%
SO_2	0
No. 2 lime kiln	0

The table shows that during the days of the inspection the monitoring equipment was recording only 80 - 90% of the total emissions. In two cases where the monitors appeared to be functioning properly, they actually were not recording actual emissions. The testing was done the week of April 16-19, and a considerable effort has since been expended by the company to correct difficulties noted during the inspection. New data has since been given the state to update previous emission data.

POND SAMPLING

AQB personnel tried to determine relative pollutant concentrations in pond emissions. Sampling in a boat on Pond #14 was conducted as a 5-10 mph west wind was blowing to eliminate possible influence of mill emissions.

Teflon bags were used to carry samples to the chromatographs and were purged with nitrogen gas to eliminate any sampling error. Limited time was allowed between bag sampling and gas chromatographic analysis at H-W's Frenchtown monitor.

Analysis results are given in Table 20. Complete calibration of the gas chromatograph was not performed so the data should be considered approximate.

Table 20

H-W AMBIENT POND SAMPLING April 19, 1974

Component of Pond Emissions	% of Total Pond Emissions
Total Sulfur	100
Dimethyl sulfide	2.0
Hydrogen sulfide	71.4
Sulfur dioxide	0.5
Methyl mercaptan	3.0
Unidentified substance (possibly carbonyl sulfide)	1.0
Undifferentiated remainder	22.1

Dimethyl disulfide definitely was not present; but other higher molecular weight sulfur compounds possibly represent the 22.1% unknown fraction. The instrument gave only one unidentifiable peak as noted. A longer column not available in Missoula would have to be used to resolve the 22.1% group.

AIRBORNE SAMPLING

Samples were taken by airplane from the air directly over and immediately around the H-W complex along with air samples taken some 50 to 75 feet above the pond water level. Wind speed was low and generally from the west. Gas chromatographic analysis of the bag samples are shown in Table 21.

Table 21

AIR SAMPLES TAKEN OVER THE PLANT AND PONDS April 18, 1974

	Sample from= over the Plant	Samples from over the Pond
Total Sulfur	100%	100%
Hydrogen sulfide	57%	76%
Sulfur dioxide	35%	5%
Unaccounted	8%	19%

OXIDATION OF SULFUR COMPOUNDS

Very little information is available pertaining to Missoula Valley conditions. Most of the studies relate to the oxidation of hydrogen sulfide by ozone (1) (2). Although ozone levels have not been characterized around Missoula, it appears from the literature that the lifetime of H_2S in the atmosphere is approximately 2 hours when the ozone content is 0.05 ppb and particulate is $15,000/cm^3$ (these conditions are typical of continental air).

The oxidation of hydrogen sulfide to sulfur dioxide to sulfate and possibly dilute sulfuric acid probably occurs in the H-W vicinity, but it is difficult to quantify such transformations on the basis of existing ambient air data. Other sulfur compounds probably undergo the same or similar oxidation processes.

HEALTH EFFECTS

Most recent health effect data have been summarized using total suspended particulates, sulfur oxides and suspended sulfates in combination.

Adverse health effects have been correlated with short-term (24-hour) conditions (13) as follows:

"Panels of healthy families in Birmingham reported an excess of irritation symptoms during a short-term exposure to 100-269 $\mu\text{g}/\text{m}^3$ of particulate matter accompanied by low levels of sulfur dioxide (13-16 $\mu\text{g}/\text{m}^3$ or 0.005-0.006 ppm) for twenty-four hours. Cough, chest discomfort, and restricted activity were most consistently elevated. Non-smokers had lower baseline reporting rates than smokers, but both were equally affected during the episode."

Missoula perhaps does have high particulate levels as does Birmingham although the chemical composition and particle size may differ. The point is that particulates with very low short term sulfur dioxide levels can adversely affect some segments of the population.

The Community Health and Environmental Surveillance System (CHESS) report further states that all particulate studies suggest health effects at or below present standards. It adds that levels of suspended sulfates were more consistently associated with observed adverse health effects and were generally one to two orders of magnitude lower than the levels of sulfur dioxide or total suspended particulates necessary to cause similar effects alone.

Adding the effects of sulfates in Table 22 we obtain from the above CHESS summary the levels for worst case effects on human health as documented by the EPA (13).

Table 22

24-HOUR POLLUTANT THRESHOLD LEVELS FOR ADVERSE HEALTH EFFECTS				
Type of Effect	Minimum 24-hr. temp.	Sulfur Dioxide	Total Suspended Particulate	Suspended Sulfate
Aggravation of cardiorespiratory symptoms in elderly patients with com- bined heart and lung disease	Greater than 40° F	16 - 20 ug/m ³ (.006-.008 ppm)	24 ug/m ³ and above	6 ug/m ³ and above
Aggravation of asthma manifest by higher attack rates	Greater than 50° F	23 ug/m ³ (.009 ppm) and above	61-75 ug/m ³	0-1 ug/m ³

CHESS study findings for adverse health effects caused by sulfates are supported by laboratory findings. Some metallic sulfates are more potent irritants than sulfur dioxide. It has also been shown that the size of the irritant particle material affects the degree of response and that within the range of 0.3 to 2.5 microns mean mass diameter, the smaller the particle size the greater the potency (13).

Detailed trace metal studies have not yet been conducted in Missoula. Most of the metals which are known to cause adverse effects when in combination with sulfates (e.g. Zn, iron (+2))(14) are probably not in high concentrations in the Missoula Valley. Ammonium sulfate, however, might be present. It is a known respiratory irritant causing airway flow resistance (14).

Recent 24-hour suspended sulfate levels in Missoula were around 14 ug/m³ and total suspended particulate values have been very high, for example 914 ug/m³ on February 28, 1974, at the courthouse.

Consequently, the Missoula Valley air at times has potential for adversely affecting health. H-W probably contributes suspended sulfates, a small amount of particulate and sulfur dioxide.

In an unpublished manuscript LeRoy Schieler points out that Kraft pulp mills in the northwestern U. S. contribute to mental depression. His 1972 study showed the following correlation (15):

ppb of H ₂ S	Percent of the sampled population with mental depression
20	21
40	50
60	65
80	70
100	75

No work on this subject has yet been carried out in the Missoula area.

DIFFUSION MODELING

A theoretical dispersion model was incorporated to estimate ambient levels of H₂S that may exist following pond aeration and proposed plant expansion at H-W. The results of this model indicate large reductions in ambient H₂S levels from the present situation. However, on occasion the half-hour standard of .03 ppm will continue to be approached and possibly exceeded.

The theoretical dispersion model utilized to estimate ambient H₂S levels incorporates the basic assumptions of a Pasquill dispersion model. The Workbook of Atmospheric Dispersion Estimates provided the assumptions needed to prepare ambient estimates. Stack parameters were extracted from H-W's permit application for new facilities.

Results of the model indicate the ponds will continue to be the major source of ambient problems. There will be little plume rise associated with pond emissions. Therefore, such emissions will tend to drift near the ground with the subsequent plume centerline near ground level also. Emissions from the plant stacks will be released from a source and therefore ground level concentrations from the plant will be markedly less than from pond emissions.

Using an average wind condition of 3.57 m/sec (8 mi/hr) and Pasquill category E, and no plume rise ambient H₂S levels (47 ppb) will exceed Montana's standard within 2.1 kilometers of the stack. Still assuming no plume rise, levels approaching 100 ppb H₂S may be reached at locations immediately adjacent to the ponds. Therefore, it is likely that the half-hour standard of 30 ppb may be exceeded frequently by pond emissions in areas adjacent to the pond. Assuming some plume rise, and this appears valid from expected aeration pond temperatures of 81.5° F in summer and 88.9° F in winter, the ambient ground level H₂S concentrations should be much less than these values.

No violation of the 30 ppb standard is expected at distances greater than 5 kilometers from the ponds.

The contribution from stack emissions will, for the most part, be negligible except when the plume impacts on terrain to the west. In those cases concentrations may reach 49 ppb H₂S. There is insufficient data available to determine the frequency of such violations. Speculation would suggest that 49 ppb H₂S may result during cold stable periods on the mountainous terrain 1½ miles to the west. When an arctic air mass descends on the Missoula Valley for an extended period of time several half-hour violations can be anticipated.

B. Water Quality

GROUNDWATER

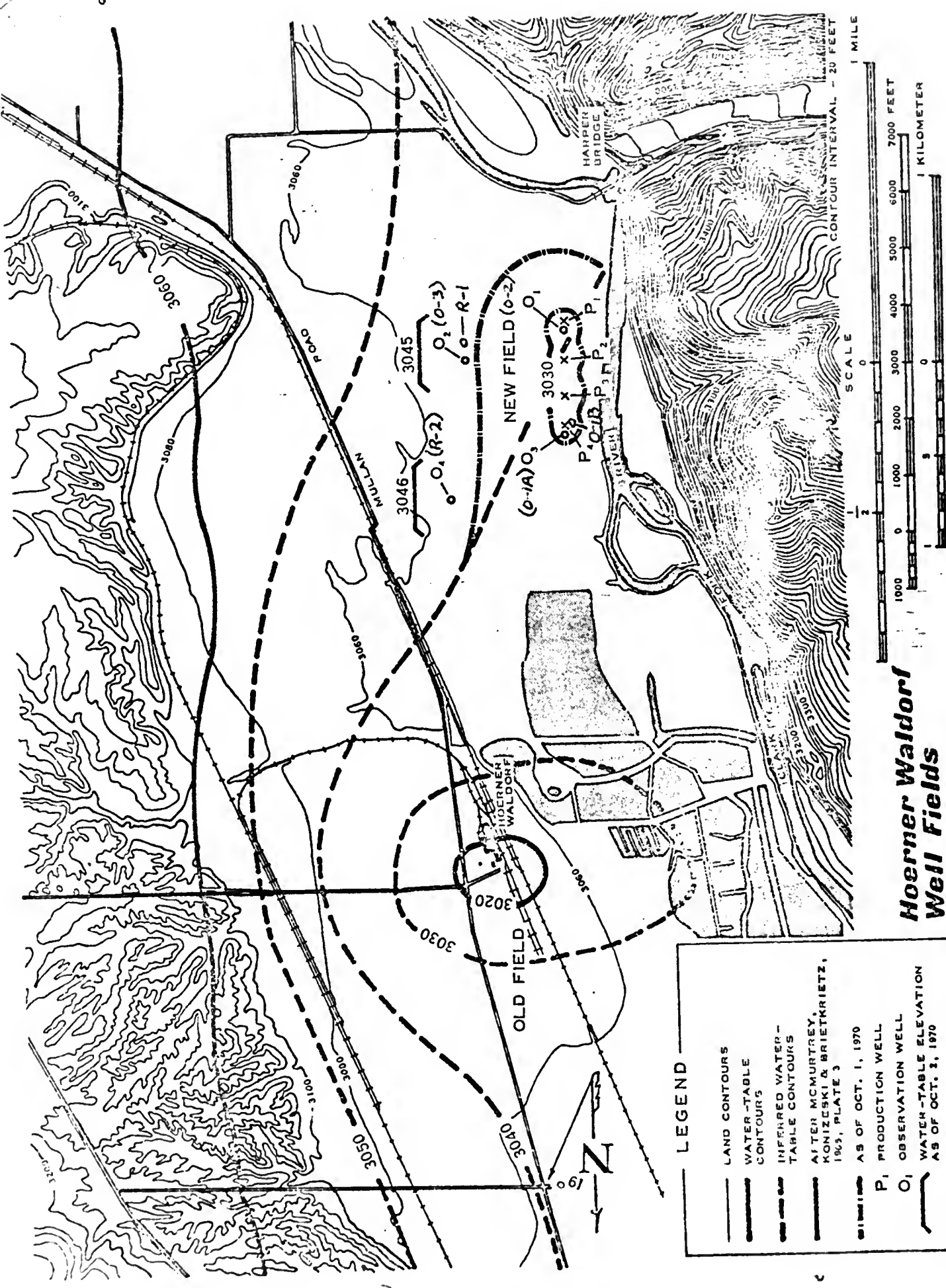
The H-W operation significantly affects groundwater in the vicinity of the mill. They have two production well fields producing about 18 mgd and the groundwater system is used for disposal of a majority of their liquid effluent (Figure 11). Approximately 15.8 mgd of effluent leaves the plant daily and is routed through a clarifier to 14 interconnecting stabilization ponds. About 10.0 mgd of effluent percolates through pond bottoms with ponds 14 and 15 accounting for about 90 percent of the total percolation. The remainder of the effluent is disposed of by evaporation (0.5 mgd) and direct discharge to the Clark Fork River during spring runoff (5.0 mgd).

PROPOSED DISPOSAL SYSTEM

The proposed expansion envisions a maximum effluent flow of 21.6 mgd (an increase of 37 percent) and a disposal system that will utilize percolation to a greater extent. H-W presently is testing a rapid infiltration system that will handle nearly all the plant effluent. With the new system, it is expected that up to 94 percent of the effluent will percolate, less than 2 percent will evaporate, and the remainder will be directly discharged to the river during spring runoff. If rapid infiltration is not completely successful, an estimated 6 to 48 percent of the mill effluent would be discharged to the river (depended on river flow).

GENERAL HYDROGEOLOGY

The general hydrogeology of the valley has been described by McMurtrey, Konizeski and Brietkrietz (16). The H-W plant is in part of the flood plain of the Clark Fork River, and numerous channels of the river are present on the property. Generally unconsolidated alluvium extends to a depth of 150 to 160 feet beneath the ground surface and is composed of an upper zone, a middle zone, and a lower zone. The upper zone consists of 25 to 35 feet of sand and



Hoerner Waldorf Well Fields

- LEGEND**
- LAND CONTOURS
 - - - WATER-TABLE CONTOURS
 - - - INFERRED WATER-TABLE CONTOURS
 - AFTER MCMURTRY, KONIEZSKI & BRIETKRIETZ, 1963, PLATE 3
 - AS OF OCT. 1, 1970
 - P_1 PRODUCTION WELL
 - O_1 OBSERVATION WELL
 - WATER-TABLE ELEVATION AS OF OCT. 1, 1970

silt with scattered gravel, cobbles and clay lenses. Beneath this is a middle zone consisting of 65 to 75 feet of fine sand, silt and clay with occasional scattered gravel. The lower zone is about 45 feet thick and is composed of sand and gravel with a few thin clay and silt lenses. The alluvium is derived from reworking of older glacial debris, lake deposits, and older Tertiary sedimentary deposits from the Missoula Valley area. The alluvium is underlain by bedrock consisting of limestone and argillite of Cambrian or Precambrian age.

There are two major aquifers in the area, one above the other. The upper aquifer is present from the ground surface to a depth of about 25 to 35 feet and is primarily composed of fine sand mixed with gravel and scattered boulders and with lenses of silt, clay, and clean gravel. The major aquifer in the area is approximately 105 to 150 feet below the ground surface and is the primary source of water for the old and new well systems at the H-W plant. This aquifer has a high hydraulic conductivity (ability to conduct water) but is used only in a few scattered domestic and stock wells near the H-W property. The lower aquifer is separated from the upper aquifer by 65 to 75 feet of fine sand, silt, and clay layers.

The lower aquifer is composed primarily of sand and gravel and is recharged by water from the Clark Fork River, other streams and by precipitation, but the area in which recharge occurs is poorly known. Recharge to the aquifer may occur miles from the H-W property. In addition to recharge from the river, the lower aquifer appears to be obtaining groundwater from the upper aquifer. The mechanism of water transfer would be "leakage" through the zone separating the upper and lower aquifers.

The general path of movement of groundwater in the area is toward the Clark Fork River (16). Pumping from well fields has altered groundwater flows by formation of cones or troughs in the water table surface. This actually is not a water table but is a piezometric surface associated with a semi-confined aquifer, but for this report will be termed as water table

surface for ease of understanding. The drawdown cones or troughs cause groundwater flow into pumping well fields from surrounding areas. The shape of this surface as drawn by H-W is shown in Figure 11.

GROUNDWATER IMPACT

The proposed plant expansion will affect groundwater in four ways:

1. Increased pumpage of water from the deep aquifer for increased plant water requirements.
2. Increased volume of liquid effluent that will be disposed of into the groundwater system.
3. Alteration of groundwater flow patterns due to significant changes in the disposal techniques.
4. Change in quality of water disposed of into the groundwater system.

WATER SUPPLY

Water supply requirements are described by H-W as follows:

The present mill uses 17.3 million gallons of water per day from deep wells in the vicinity of the plant. Five wells are located at the plant site and produce 1/3 of the water requirements. The remaining water comes from four wells two miles south and upstream from the plant.

With the expansion, water requirements will increase to 28.8 million gallons per day, when the maximum quantity of bleached pulp is manufactured. Three new wells will be drilled. H-W has received assurance from a competent hydrologist that this increased supply can be obtained without any adverse effect on the producing aquifers (17).

The hydrologic impact of three new production wells was not determined by H-W. The hydrologic consultant stated that "it would be very difficult to predict the contours of the expanded well field, but it is reasonable to expect that the additional influence will be confined to the localized area around the well field."

The three additional wells will be drilled in the vicinity of the new well field (Figure 1b). The impact of these wells depends on their exact

location and proposed pumping schedule. Based on aquifer characteristics, the impact of such wells on the groundwater system could be estimated. These additional wells will further decrease the hydrostatic head in the deep aquifer and the aquifer is rapidly recharged by overlying and nearby groundwater; thus, the additional increase in pumpage of 9.5 mgd of 55 percent from this deep aquifer probably will not cause substantial changes in hydrostatic pressures outside the H-W property.

EFFLUENT DISPOSAL

Both the disposal technique and the volume of effluent will significantly change with the proposed plant expansion. As indicated earlier the major volume of wastewater is disposed by seepage to the groundwater, which in turn reaches the river. The ponding system has been expanded as seepage rates here declined in the older ponds. H-W recently has begun experimenting with rapid infiltration basins which, if successful as predicted by H-W consultants, will permit ground disposal of the majority of the treated effluent. The proposed infiltration system would be utilized following the aerated stabilization basins and settling ponds. H-W describes this system and the experimental work being done as follows:

Briefly, reduced percolation from the existing ponds is due to the soil sealing at or near the surface. Sealing is caused by the surface growth of bacterial slimes, evaporation and flocculation of dissolved organic matter and possibly by the formation of ferrous sulfide in the soil. Because these bacteria generate ferrous sulfide, their presence is indicated by localized concentrations of iron and organics. Analysis of the pond bottom at H-W indicates a higher than normal localized iron and organic concentration exists between 0 and 16 inches beneath the soil surface. Similar tests conducted in conjunction with permeability studies indicate that the treatest degree of plugging occurs in the region of high iron and organic concentrations.

As explained, a solution to anaerobic plugging is to rapidly infiltrate effluent into the soil to the point just prior to establishing anaerobic conditions. Then, allowing the soil to dry, will induce oxidation of ferrous sulfide and aerobic breakdown by any organics to CO₂ and H₂O. The installation of secondary treatment will also help this situation by greatly reducing the tendency of the effluent to become anaerobic.

In order to determine the appropriate dosing and drying time periods, two rapid infiltration basins were constructed in the late fall of 1973. The first basin constructed contained an actual area of 4.15 acres, the second 7.33 acres. As of mid-February, the first basin had been operated thru seven cycles of approximately 6.9 million gallons per cycle, and the second basin had been operated thru five cycles of approximately 10.0 million gallons per cycle. Dr. Al Wallace will prepare a detailed summary of results to date, for submission as supporting information on this system.

If rapid infiltration is successful, it would have the following advantages:

1. Economically, it would be the best method, because it utilizes present structures and will require a minimum of additional resources.
2. Test well data indicates a high degree of BOD removal via this route.
3. It is projected that the expanded mill will meet the color standard via this route.
4. Because of the nature of underground water flows, no localized high concentrations of effluent result, as would be the case at the end of a discharge pipe.

The infiltration test basins and associated water quality monitoring wells are shown in Figure 3. The test well and water quality sampling program is being conducted by H-W as part of a cooperative study between H-W and the University of Montana. Some of the older, tightly sealed ponds south and west of the plant will be redeveloped for use as rapid infiltration areas. If rapid infiltration proves successful as a long-term disposal strategy, it is expected that there will be flexibility in the choice of areas to be utilized for disposal; thus, some control can be exerted on groundwater flow patterns,

There have been no substantiated cases of groundwater quality or water table elevation changes peripheral to the H-W property; thus, existing groundwater flow patterns of pond effluent appear to be relatively restricted. There are only a few private wells near the H-W area, and the H-W monitoring and test well net is not extensive, so the areal extent of groundwater influenced by seepage of wastes is not clearly defined.

A general groundwater flow direction toward the river presently exists in the upper aquifer. The anticipated effluent of 21.6 mgd and a possible 94 percent percolation disposal results in a potential total disposal of 20.3 mgd to the shallow groundwater system or an increase of 103 percent from the present ground disposal of 10.2 mgd. The impact of this added volume on existing groundwater flow pattern cannot be predicted from the available data. Of principal concern will be the required horizontal area needed to move 20.3 mgd through the shallow groundwater system. There also is definite evidence of vertical movement of waste effluent from the upper shallow aquifer into the deep aquifer. Movement of dissolved chemicals from waste ponds into plant production wells tapping the deep aquifer has been detected. This interaquifer movement has been accentuated by drawdown in the old plant production wells. The general extent and long-range implications of vertical interaquifer movement of wastewaters are not known.

The shallow aquifer system has a good ability to transmit water and has, for a number of years, accommodated the disposal of 10.0 mgd of wastes. Preliminary test infiltration pond data and general considerations of this practice at H-W (A. T. Wallace private report to H-W) indicates a rapid infiltration disposal system may be feasible.

Dissolved constituents abundant in the effluent ponds are present in a diluted concentration in production wells located near the plant. These wells are known to be completed in the deep aquifer. Downstream from the H-W ponds, water quality data from recent test wells indicates limited vertical movement of mill effluent. Figure 12 (from a consultant report to H-W) illustrates the decrease in sodium with depth in these wells.

FIGURE 12

CHANGE IN SODIUM CONCENTRATION WITH
DEPTH OF TEST WELLS DOWNSTREAM FROM
HOERNER WALDORF PONDS

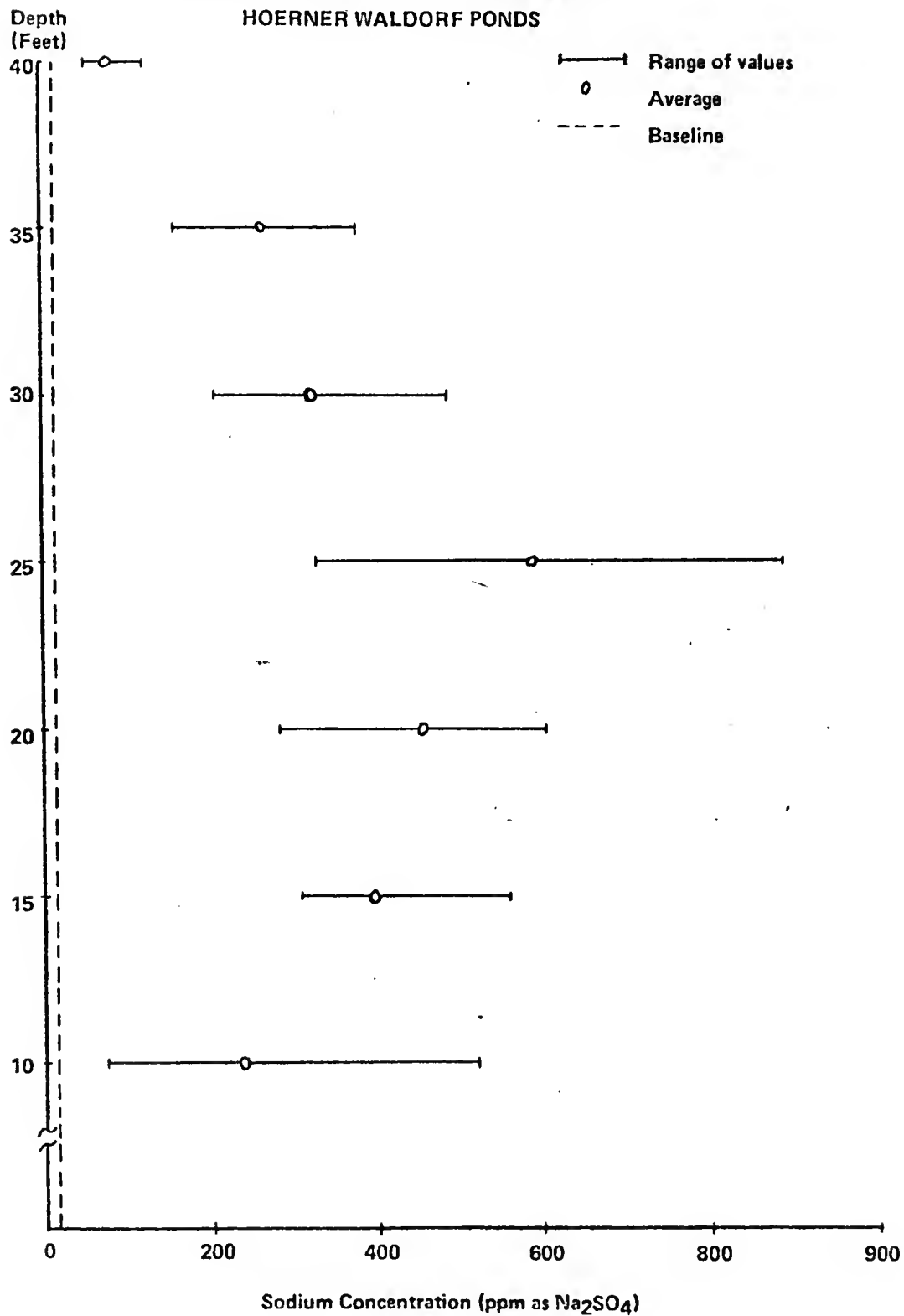


TABLE 23 . TYPICAL CHEMICAL QUALITY OF GROUNDWATER IN WELLS ON AND NEAR THE HOERNER-WALDORF PROPERTY

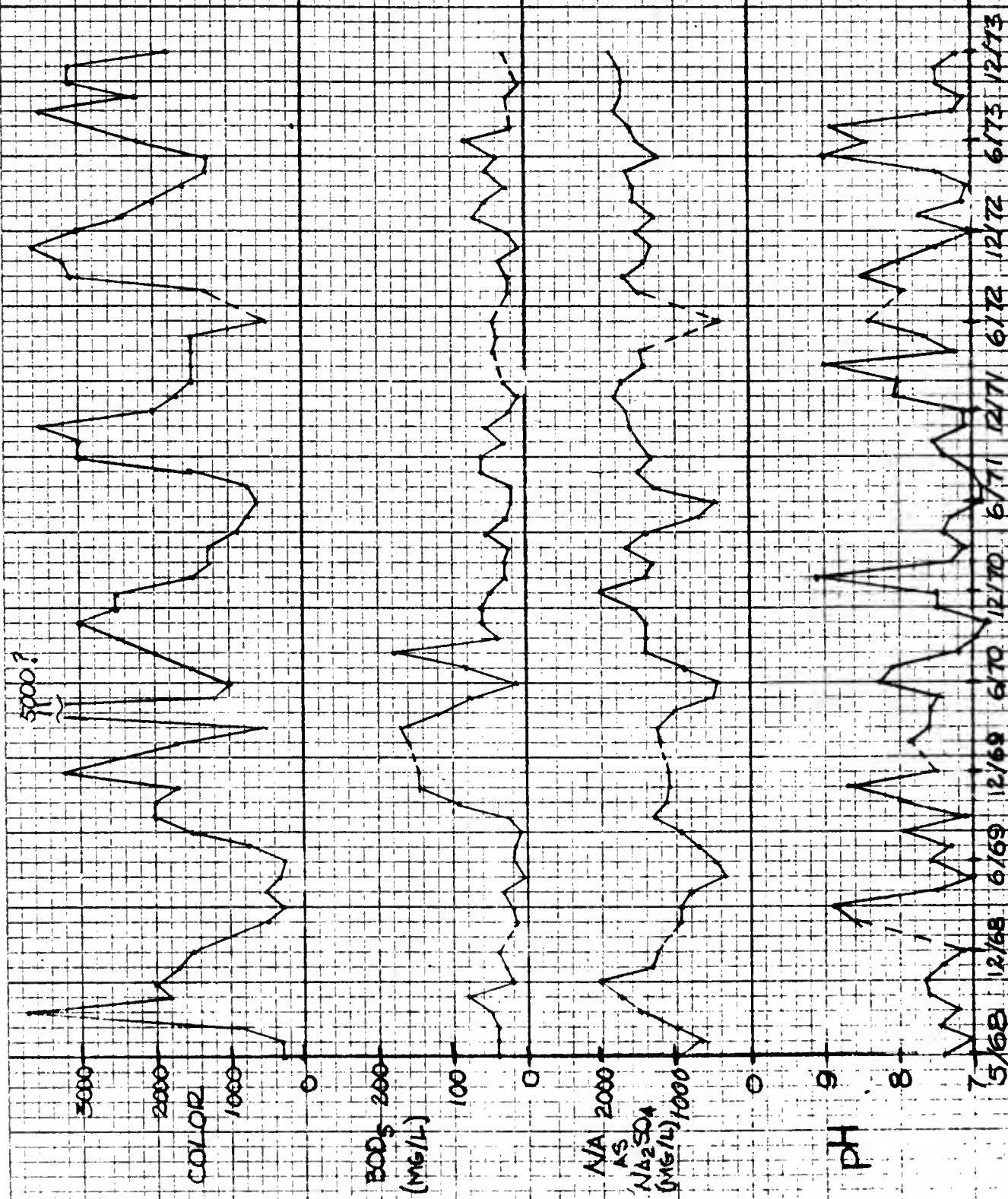
Water Analyses by the Montana Department of Health and Environmental Sciences

All units in milligrams per liter except where shown otherwise.

Sampling Station	Date Sampled	Temperature (°C)	pH (S.U.)	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Specific Conductance (u _h mo/cm at 25°C)	Color (CU)	Reported Depth (Ft.)
Pvt. Well 1	2-14-74	10.6	8.10	48	15	12	218	28	2.5	2.78	396	<5	162
Pvt. Well 2	2-14-74	9.4	7.81	75	25	25	249	89	4.5	5.89	648	<5	50
Pvt. Well 3	4-3-74	6.0				18		59	7.7		441	<5	40
Pvt. Well 4	4-3-74	10.0				18		41	1.9		399	<5	unknown
Pvt. Well 5	4-3-74	10.4				21		57	15.4		698	<5	unknown
Composite H-W new well field	4-17-74												
School Well	4-4-74	10	7.80	51	17.7	13.5 3.2	224	37 12	2.0 0.1	1.1	424 237	<5	200
Pvt. Well 6	5-6-74					15						<5	unknown
Pvt. Well 7	5-6-74					10						<5	157
Pvt. Well 9	5-6-74					25						<5	48
Pvt. Well 10	4-4-74	6.5				19		49	1.2		549	<5	unknown
Pvt. Well 11*	4-4-74	8.2				84		32	0.2		370	<5	45
Pvt. Well 12	5-6-74					4.8						<5	42
Pond 13	4-3-74	8.6	8.40			530					2295		
Test Well 5	2-14-74	8.6	7.96	31	10.2	170	411	43	73	1.50	926		

*Sample taken after softening.

Fluctuations of color, BOD_5 , sodium and pH in well 2R from May 1968 to December 1973.



QUALITY CHANGES IN THE GROUNDWATER SYSTEM

Wells to measure the direction of groundwater movement and changes in composition of percolated wastewater have been present since 1968, and several wells in the area are used as domestic supplies. Typical water quality data from the area is shown in Table 23. A summary of a portion of the area obtained by H-W to determine quality changes in the groundwater during 1973 is shown in Table 24.

Table 24

REDUCTION IN BOD AND SODIUM IN GROUNDWATER SYSTEM

Test Well No.	BOD mg/l	Percent Reduction in Aquifer	Sodium mg/l	Color Units	Percent Reduction in aquifer	Elevation of Water in Wells - feet above sea level
2	38	93	522	2050	27	--
4	33	93	450	1476	39	3028.1
5	17	92	228	482	59	3027.2
404	31	83	187	845	12	3035.1
421	14	93	203	547	48	3029.2
423	35	82	206	380	64	3030.9
514	5	96	139	188	73	3027.6

The average removal of BOD and color obtained during the year (Table 24) represent the concentrations from the time it left the plant to the time it arrived in the test well. There are fluctuations in water quality in these wells due to precipitation, rate of pond seepage, and river stage (Figure 13). There are a number of assumptions used in this calculation.

These are:

1. Average pond concentrations of sodium, BOD, and color are constant and are: 558 mg/l, 560 mg/l and 3000 cu (color units) respectively.
2. Sodium is assumed to be conservative; that is, its concentration is changed only by dilution, and it is not sorbed or desorbed by the soil system.

3. Background sodium in groundwaters unaffected by pond wastes is 12 mg/l.
4. Wastes travel in the upper aquifer and are accurately sampled by the monitoring wells.

None of these assumptions exactly reflects the real system, but they are thought to be reasonable approximations. Average pond values for sodium, BOD, and color are based on the average of each pond for each month during 1973. These values were reasonably consistent during the year. Sodium can be adsorbed by soils and thus may not be conservative. Adsorption would, however, lower the apparent reduction percentage; that is, the actual in-the-ground reduction would be greater than the calculated reduction. After five years of disposal of high sodium wastes, the adsorption capacity of the soil for sodium ions may be exhausted and the assumption that sodium is conservative may be valid. Background sodium values are not well known but appear to be in the range of 8 to 25 mg/l with 12 mg/l a reasonable approximation. Color and BOD removal percentages are not very sensitive to error in assumed background sodium in the 8 to 25 mg/l range. Based on all available data, wastes appear to travel primarily in the upper aquifer.

These calculations provide a rough estimate of removal of color and BOD in the soil. The mechanism of color removal in the groundwater system at H-W is unknown. Possible mechanisms are: (a) sorption or chemical reaction with earth materials or groundwater in the aquifer; (b) chemical or biological alteration of color-producing compounds to non-color producing compounds. Removal of BOD probably involves physical filtration of organic particulates in the aquifer and possible anaerobic biological decomposition in portions of the aquifer.

It can only be speculated at this time that color reduction will continue to be obtained with the aerobic effluent from the proposed aerated stabilization basins and the rapid infiltration system.

SURFACE WATER QUALITY

The Clark Fork River drainage basin upstream from Missoula has an area of about 9,300 square miles and includes the Bitterroot, Blackfoot and the Little Blackfoot River drainages. The river generally is a good quality calcium-bicarbonate type water with low to moderate concentrations of dissolved minerals. Water quality based on data collected by the U.S.G.S. from 1968 to 1971 above and below Missoula is summarized in Tables 24 and 25. The Clark Fork River in the Missoula area is classified by the state of Montana as a B-D1 stream. Details of the classification are given elsewhere in this report. At times in the past, concentrations of iron, copper, zinc, lead and manganese have been high. This was principally due to wastes from upstream metal processing activities of the Anaconda Company. Recent industrial improvements in the Anaconda Company Butte operations have significantly reduced metal concentrations and future improvements will further reduce metal loads.

A number of investigations recently have been conducted on the Clark For River to determine the effects of the H-W discharge on water quality. These investigations are:

<u>Date</u>	<u>Investigating Group</u>	<u>Parameters Measured</u>
April-June, 1973	Montana Fish and Game Department (18)	DO, temperature, turbidity, specific conductance
May 30-31, 1973	Water Quality Bureau	DO, BOD, color, temperature
1973 (discharge season) May-June	H-W Corp. (19)	DO
1973 (discharge season) May-June	Ecological Consulting Service	DO, aquatic biology
July 23,-August, 1973	U.S. Environmental Protection Agency (20)	DO, temperature, pH, specific conductance, BOD (5-day), coli-forms (total and fecal), fecal streptocococcus, qualitative and quantitative aquatic invertebrates
August 2 and 3 1974	Water Quality Bureau and Montana Fish and Game Department	DO, BOD, toxic metals, temperature

Table 24

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CLARK RICHARD ABOVE MISCELL

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PACIFIC NORTHWEST

CLARK FORK PENN CREEK RIVER BASIN

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CLARK FORK ABOVE MISSOULA
30 MONTANA
PACIFIC NORTHWEST
CLARK FORK FENN CREILLE RIVER BASIN
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02111204
CCCC

INDEX	PARAMETER	MEAN	VARIANCE	STAN. DEV.	CLEF. VAR.	STANC. ER.	MAXIMUM	MINIMUM	BEG. DATE	END. DATE
1234567	ARSENIC	3.00000	5.25412	2.30089	.766965	.542326	7.00000	.00000	65/04/16	71/04/07
1234567	BARIUM	16.00000	.00000	.00000	.00000	.00000	.00000	.00000	65/07/16	71/04/08
1234567	BERYLLIUM	5.00000	.00000	.00000	.00000	.00000	.00000	.00000	70/03/18	71/04/07
1234567	BORON	24.18.5752	285.650	16.9012	.909686	3.44594	60.0000	.00000	65/07/16	71/06/02
1234567	CADMIUM	17.011765	.002353	.048507	4.12310	.011765	.20000	.00000	65/07/16	71/04/07
1234567	CHROMIUM	17.00000	.00000	.00000	.00000	.00000	.00000	.00000	65/07/16	71/04/07
1234567	COBALT	17.177055	1.54197	.352075	2.21775	.055235	1.0000	.00000	65/07/16	71/04/07
1234567	COPPER	36.26.5597	7627.71	87.3368	3.28337	14.5561	530.000	.00000	68/04/16	71/06/02
1234567	COPPER	5.54.0000	20420.0	142.534	1.52057	63.9218	240.000	10.000	70/10/07	71/06/02
1234567	COPPER	10.807.500	1552566	1246.02	1.54306	394.026	4200.00	50.000	68/10/08	71/06/02
1234567	IRON	23.22.1578	1262.53	25.8124	1.11365	7.46740	140.000	.00000	65/07/16	71/06/02
1234567	LEAD	37.14.0766	656.655	25.9483	2.12721	4.52346	133.000	.00000	68/04/16	71/06/02
1234567	LEAD	5.15.6000	657.600	26.4155	1.34775	11.6136	66.0000	1.0000	70/10/07	71/06/02
1234567	MANGANESE	7.142.714	25051.6	156.403	1.10953	55.6708	450.000	25.000	65/07/10	71/06/02
1234567	MANGANESE	15.44.2631	1567.32	39.6411	.50000	5.14018	152.000	.00000	65/10/16	71/06/02
1234567	MOLY	17.4.11765	16.7353	4.23062	1.05115	1.04580	13.0000	.00000	65/07/10	71/06/02
1234567	NICKEL	17.1.94176	13.1814	2.63062	1.86975	.86055	15.0000	.00000	65/07/16	71/06/02
1234567	SILVER	17.118225	.110153	.321853	2.60706	.080456	1.00000	.00000	65/07/16	71/06/02
1234567	STRONTIUM	22.290.045	7018.62	83.7772	.288642	17.6413	366.000	105.000	65/07/16	71/06/02
1234567	STRONTIUM	5.170.000	6880.00	62.9458	.471283	37.0945	270.000	60.000	70/10/07	71/06/02
1234567	TUNGSTEN	18.633333	.251765	.501762	.752266	.116266	2.00000	.00000	65/07/16	71/06/02
1234567	ZINC	35.52.5542	6434.15	80.2132	1.52625	13.5565	360.000	10.000	70/10/07	71/06/02
1234567	ZINC	5.162.000	51570.0	227.050	1.40175	101.558	540.000	10.000	65/07/16	71/06/02
1234567	ALUMINUM	5.100.000	5000.00	70.7107	.707107	21.6228	200.000	.00000	65/07/16	71/06/02
1234567	ALUMINUM	12.85.4167	2552.82	50.5157	.596132	14.6593	152.000	30.000	65/10/16	71/06/02
1234567	SELENIUM	17.3.54118	13.6386	3.12000	.543665	.902246	13.0000	.00000	65/07/16	71/06/02
1234567	TOT. CO. I	22.402.682	887153	541.851	2.33954	200.812	260.000	4.0000	65/07/16	71/06/02
1234567	TOT. CO. I	14.1086.07	2454777	1566.77	1.44260	418.738	5200.00	25.000	68/04/16	71/06/02
1234567	TOT. CO. I	15.77.1053	14226.7	115.276	1.54652	27.3637	420.000	.00000	65/10/16	71/06/02
1234567	RESIDUE	16.275.375	11900.0	105.087	.356140	27.2718	358.000	.00000	65/07/10	71/04/07
1234567	RESIDUE	18.2108.61	1476195	1214.55	.576204	286.375	4630.00	754.000	65/07/10	71/04/07
1234567	PHOS-T	16.373125	.021836	.147771	.356035	.036543	.54000	.00000	68/04/16	71/06/02
1234567	AMMONIA	4.029595	.002200	.041111	.513061	.023452	1.0000	.00000	71/02/02	71/06/02
1234567	NITRATE	17.382353	.135254	.367823	.962000	.085210	1.3000	.00000	65/07/10	71/06/02
1234567	NITRATE	15.016667	.000181	.013452	.807117	.003473	.05000	.00000	65/07/16	71/06/02
1234567	NITRATE	11.156362	.068126	.261009	1.06925	.073657	.50000	.00000	70/07/12	71/06/02
1234567	MERCURY	6.318333	.124417	.352727	1.10805	.144000	1.0000	.00559	70/11/04	71/06/02

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46 55 33.0 114 26 45.0 2
CLARK FCRR NEAR ALBERTON MONTANA
3C MONTANA
PACIFIC NORTHWEST
CLARK FCRR FEND OREILLE RIVER BASIN
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0111204
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INDEX	1210001	CCT52C	PARAMETER	NUMBER	MEAN	VARIANCE	STAN DEV	Coeff VAR	STAND ER	MAXIMUM	MINIMUM	ECC DATE	END DATE
11000	ARSENIC	AS, DISS	UG/L	12	2.6153E	5.75641	2.35925	.517362	.665432	9.00000	.00000	68/04/16	70/06/05
11005	BARIUM	BA, DISS	UG/L	12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	70/06/05
11010	BERYLLIUM	BE, DISS	UG/L	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/06/05
11020	BORON	F, DISS	UG/L	23	1E+682C	264.214	16.2517	.670167	3.38557	6C.0000	.005872	65/07/10	71/06/03
11025	CADMIUM	CD, DISS	UG/L	12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	70/06/05
11030	CHROMIUM	CR, DISS	UG/L	12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	70/06/05
11035	COBALT	CA, TOT	UG/L	12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	65/10/16	69/11/12
11040	COPPER	CF, DISS	UG/L	12	.000000	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	70/06/05
11042	COPPER	CL, DISS	UG/L	37	12.9138	278.901	16.7003	1.20027	2.74552	65.0000	.000000	68/04/16	71/06/03
11045	COPPER	CL, TOT	UG/L	3	86.6667	17633.2	132.791	1.53220	76.6667	240.000	1C.0000	70/10/06	71/04/07
11045	IRON	FE, TOT	UG/L	1C	534.200	400537	632.860	1.18472	200.124	1500.00	1C.0000	68/10/25	71/04/07
11046	IRON	FE, DISS	UG/L	22	43.1559	2623.48	51.2155	1.16576	10.9201	200.000	.000000	65/07/10	71/06/03
11046	LEAD	PR, DISS	UG/L	26	15.6667	446.232	21.1266	1.34851	12.1574	40.0000	.000000	65/07/10	71/06/03
11051	LEAD	FR, TOT	UG/L	3	15.6667	446.232	21.1266	1.34851	12.1574	40.0000	.000000	65/07/10	71/06/03
11055	MANGANESE	MN, DISS	UG/L	5	66.0000	6560.00	3754.81	61.6163	1.05736	.541134	1C.0000	65/07/10	70/06/05
11060	NICKEL	NI, DISS	UG/L	12	4.56667	44.1806	6.64665	1.45551	1.51878	20.0000	.000000	65/07/10	70/06/05
11075	SILVER	AG, DISS	UG/L	12	2.08333	10.6288	3.26018	1.05736	.541134	1C.0000	.000000	65/07/10	70/06/05
11080	STRONTIUM	SR, DISS	UG/L	22	241.455	4629.85	68.0430	.281805	14.5066	340.000	7C.0000	65/07/10	71/06/03
11082	STRONTIUM	SR, TOT	UG/L	3	123.333	4423.35	60.2081	.650336	46.3062	200.000	4C.0000	70/10/06	71/04/07
11085	STRONTIUM	V, DISS	UG/L	12	.725000	.074773	.273447	.377168	.076527	1.00000	.200000	65/07/10	70/06/05
11090	ZINC	ZN, DISS	UG/L	24	46.5885	4707.66	46.6124	1.41210	11.4354	385.000	.000000	68/04/16	71/06/03
11092	ZINC	ZN, TOT	UG/L	3	163.232	18033.4	134.238	.822174	77.5314	260.000	1C.0000	70/10/06	71/04/07
11105	ALUMINUM	AL, TOT	UG/L	2	66.6667	3333.34	57.7350	.866026	33.3333	100.000	.000000	65/07/10	65/09/16
11106	ALUMINUM	AL, DISS	UG/L	5	77.3555	5185.64	72.0114	.930914	24.0038	213.000	5.20000	65/10/16	70/06/05
11145	SELENIUM	SE, DISS	UG/L	12	2.78333	5.02152	2.24066	.552203	.646866	6.00000	.000000	65/07/10	70/06/05
21501	TOT COLI	MP, TEN, BO	/100ML	21	243.361	207787	455.837	1.87253	59.4717	2000.00	3.00000	65/07/10	71/06/03
21503	TOT COLI	MF, BLE, DO	/100ML	15	714.666	672622	820.745	1.14843	211.515	2300.00	15.0000	68/04/16	65/07/06
31616	FEC COLI	CF, TEN, BO	/100ML	16	38.2778	3696.68	60.8168	1.58883	14.3247	230.000	.000000	65/07/10	71/06/03
70300	RESIDUE	P155-1EC	TONS PER	18	211.400	2789.12	455.837	1.87253	59.4717	2000.00	3.00000	65/07/10	71/06/03
70302	DISS SOL	TONS PER	MG/L	16	265375	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	71/06/03
70303	DISS SOL	TONS PER	MG/L	16	265375	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	71/06/03
70507	PHOS-T	ORTHO	MG/L	24	.017517	.000000	.000000	.000000	.000000	.000000	.000000	65/07/10	71/06/03
71845	AMMONIA	TCT-NH4	MG/L	4	.030000	.002200	.046004	1.56349	.002452	1.00000	.000000	71/02/02	71/06/03
71850	NITRATE	TCT-NH3	MG/L	16	.512500	.365166	.552419	1.07789	.138105	2.20000	.100000	65/07/10	70/12/01
71855	NITRATE	TCT-NC2	MG/L	14	.016428	.000005	.007450	.453452	.001591	.030000	.000000	65/07/10	71/04/07
71890	MERCURY	Hg, DISS	UG/L	11	.083636	.006325	.056569	1.15463	.025117	.300000	.000000	70/07/11	71/06/03
71900	MERCURY	Hg, TOTAL	UG/L	7	.157143	.006151	.076620	.500650	.025738	.300000	.100000	70/11/03	71/06/03

The Department of Health and Environmental Sciences Clark Fork River survey of May, 1973, was during the direct discharge of wastewaters by H-W. The ratio of river to wastewater at this time was approximately 170:1. Results of this survey (table 26) indicated a reduction in dissolved oxygen, a biochemical oxygen demand, and a significant increase in color downstream from the plant.

At the request of SDHES the Environmental Protection Agency made a stream survey of the Clark Fork River in the vicinity of the H-W plant in July 23 to August 3, 1973. The survey was requested at this time because stream flow in July and August of 1973 was the fifth lowest in 44 years of record. Average daily river flow during this period ranged from 1,280 to 1,690 cfs (cubic feet per second) and averaged 1,465 cfs.

The following conclusions are taken from the EPA report (20):

Results of the grab samples indicated that at no time during the study did the dissolved oxygen concentrations in the Clark Fork River fall below the 7.0 mg/l criteria. The plot of average dissolved oxygen concentrations at each sampling station (Figure not included with this environmental impact statement) indicates a fairly uniform dissolved oxygen concentration throughout the study reach with a variation of only 1.3 mg/l from upstream of all sources of wastes (Station CF-US) to the downstream limit of the study (Station CF-8). A variation of only 0.4 mg/l occurred in the reach from upstream of the H-W ponds (Station CF-1) to the furthestmost downstream station (Station CF-8).

The results of the biochemical oxygen demand test which measures the relative oxygen requirements of municipal and industrial wastes, indicated the concentrations in the Clark Fork River from Missoula to the station downstream of Alberton, a distance of 62.6 km (39.1 miles), to be within a relatively narrow range of 1.3 - 3.0 mg/l (Figure -not included with this environmental impact statement). Although the BOD concentrations in the side channel near the H-W ponds reached an average of 5.1 mg/l (maximum 16.2 mg/l), only a slight increase from 1.3 to 1.8 mg/l was evident in the river.

Coliform criteria applicable to the reach of the Clark Fork River included in this study require that the average density of total coliform organisms be less than 1000/100 ml. Results of the study indicated that the total coliform densities remained less than this limit throughout the study reach (Figure - not included with this environmental impact statement.)

TABLE 26

RESULTS OF STREAM SURVEY ON CLARK FORK RIVER - May 30 and 31, 1974
by the Water Quality Bureau, Department of Health and Environmental Sciences

SAMPLE LOCATION		Estimated Miles Above or Below Pulp Mill Discharge		DATE	TIME	RIVER TEMPERATURE °F	DO mg/l	BOD mg/l	COLOR* units Pt-Co
Description									
At Harpers Bridge south side	3 above	5-30-73	1:45p 6:30a	57 57		9.1 8.4	0.9	5	
At Marcure's Ranch below pulp mill	1 below	5-30-73	2:45p	58		8.6			
One mile below Huson north side	9 below	5-30-73 5-31-73	5:00p 6:00a	60 58		8.4 8.0	2.2 1.5	18 19	
Below Alberton at west bound highway rest stop	25 below	5-30-73	5:30p	60		8.0	1.7	17	
Below Alberton at east bound highway rest stop	26 below	5-31-73	5:30a	58		8.0	1.1	16	
Above Superior about 1 mile on north side	53 below	5-30-73	6:30a	58		8.8	2.0	13	
Above Superior at interstate bridge east side	52 below	5-31-73	4:45a	59		7.8	1.0	11	
At St. Regis highway bridge - east side	67 below	5-30-73	8:15p	59		8.6	2.2	14	
East of Paradise 3 miles at Highway 200 bridge - east side	91 below	5-30-73	9:00p	59		8.6	2.2	14	

*Color determinations were not made within the maximum recommended storage time.

Fecal coliform organisms, indicators of recent pollution, were found at all sampling locations (Figure -not included with this environmental impact statement). Mean densities were less than 100/100 ml at all river locations with the exception of Station CF-DS, downstream of the discharges from the Missoula Wastewater Treatment Plant and the Dailey Packing Plant, where the mean density was 144/100 ml (maximum 7,300/100 ml). A high density of fecal organisms (mean 190/100 ml) was present in the side channel of the river containing seepage from the H-W ponds, however, no increase in coliform densities in the river could be attributed to the pond seepage.

Although color determinations in the reach of the Clark Fork River did not exceed 5 units above background (that found in the upstream control station), it can be seen that wastes entering the river in the vicinity of the H-W ponds produced an incremental increase of 5 units to a color intensity of about 10 units. This condition persisted downstream to the limit of the study reach (Figure - not included in this environmental impact statement).

Conductivity measurements showed a small increase in the average conductivity from 309 to 316 umhos (Station CF-1 to Station CF-3) within the reach of river which receives wastes from the H-W ponds. A conductivity cross-section made at Station CF-3, opposite the H-W ponds, showed that the conductivity progressively increased from the west bank of the river to the east bank where the ponds are located (Figure -not included in this environmental impact statement.)

It should be noted that dissolved oxygen samples during the EPA study were obtained during daylight hours, and night time samples would have given lower DO concentrations.

The April to June, 1973 investigation of the Clark Fork River by the Montana Department of Fish and Game gave the following results:

A comparison of diurnal dissolved-oxygen sags prior to and during a H-W kraft mill waste discharge shows a marked reduction in the amount of dissolved-oxygen below the Kraft mill effluent discharge points during the discharge period (see Figures and -not included in this environmental impact statement). A dissolved-oxygen reading of 6.9 ppm occurred at the Marcure Ranch station during the 4:00 A.M. sampling period on May 24, 1973 while the D.O. at the Harpers Bridge Station (8V5p99m) was 1.6 ppm higher (Figure - not included in this environmental impact statement). The 6.9 ppm level of dissolved-oxygen was in violation of the Water Pollution Control and Helena personnel were notified. Apparently up until this period only daily noon samples for dissolved-oxygen were being determined by H-W. Subsequent diurnal sampling by H-W and the

Department of Fish and Game showed some discrepancy in results, however, comparisons of dissolved-oxygen obtained at selected stations found H-W generally higher than other participants (see memo by Whipperman, May 31, 1973). Following this meeting, diurnal sampling showed a sag of up to 1 ppm (Figure - not included in this environmental impact statement).

Temperature data indicate an increase in temperature between Harpers Bridge and the Marcure Ranch station.

Turbidity determinations fluctuated and showed no consistent trends.

Conductivity data shows a definite increase between Harpers Bridge and the Marcure Ranch during the discharge period. However, lower levels at Huson would indicate that dilution occurs between these sampling points.

Dissolved oxygen values reported by the Fish and Game Department on May 23 and 24 were during a period where the ratio of river flow to wastewater discharge was approximately 130:1.

H-W reports the results of 1973 DO tests as follows:

H-W conducted additional diurnal oxygen measurements of the Clark Fork River during the entire direct discharge period of 1973. No violation of the water quality standards occurred during this period.

On August 2 and 3, 1973, the SDHES, in cooperation with the Department of Fish and Game did a 24-hour DO, BOD and temperature survey of the Clark Fork River above and below the H-W plant. Results from stations above and below the plant are shown in Figures 14 and 15 respectively. Results showed no significant change in DO from the upstream to the downstream stations. The average BOD upstream and downstream from the mill was 1.0 mg/l and 0.8 mg/l, respectively.

Several water samples were taken from the Clark Fork River by the Department of Health and Environmental Sciences in the winter of 1973-74. Results of this sampling indicated no significant quality changes in the river between the upstream station (above the mill) and the downstream station (below the mill near Huson). The samples also showed no violations of Montana's water quality standards.

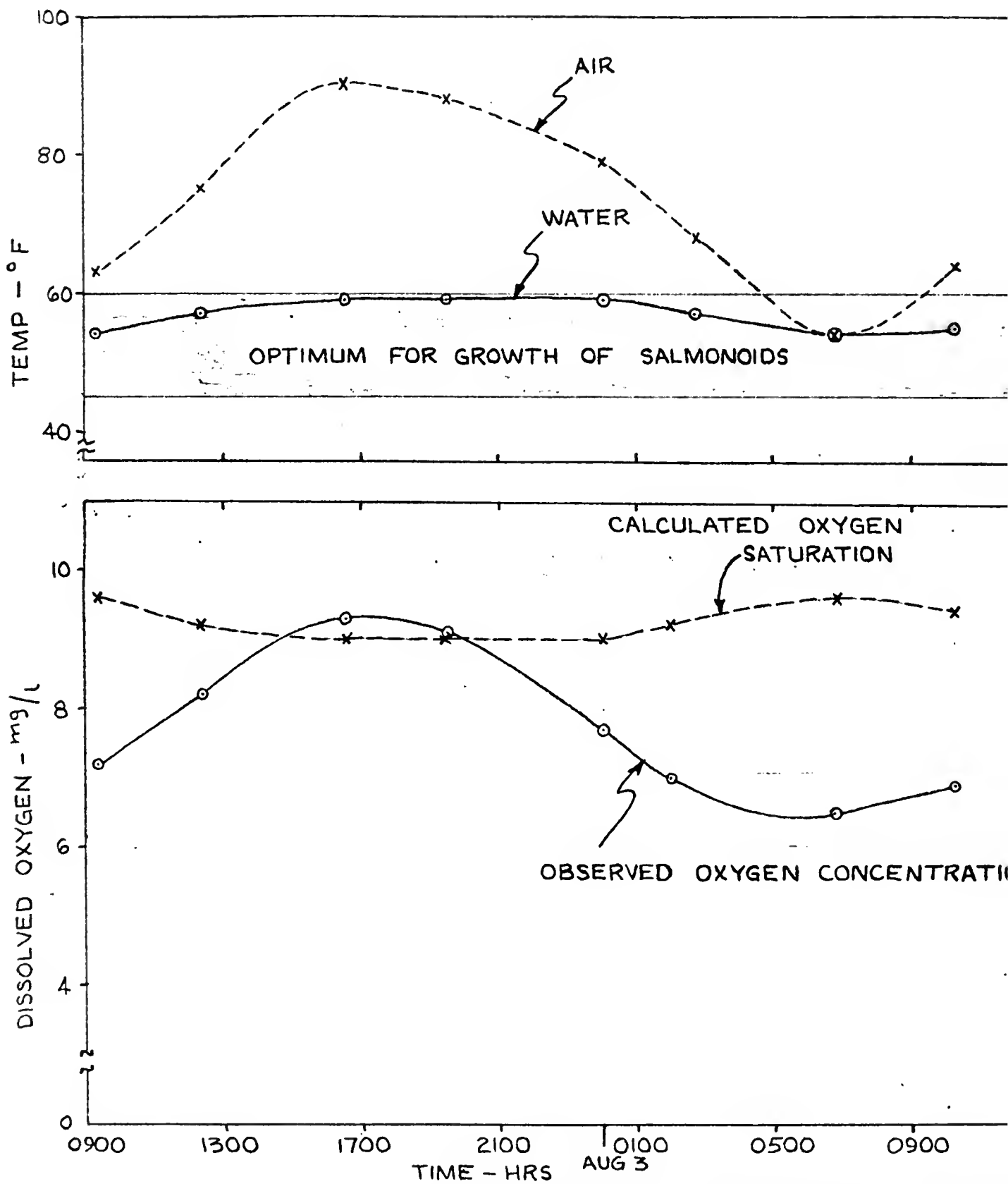


FIGURE 14 . DISSOLVED OXYGEN AND TEMPERATURE DIURNAL VARIATIONS FOR CLARK FORK R AT HARPER'S BRIDGE

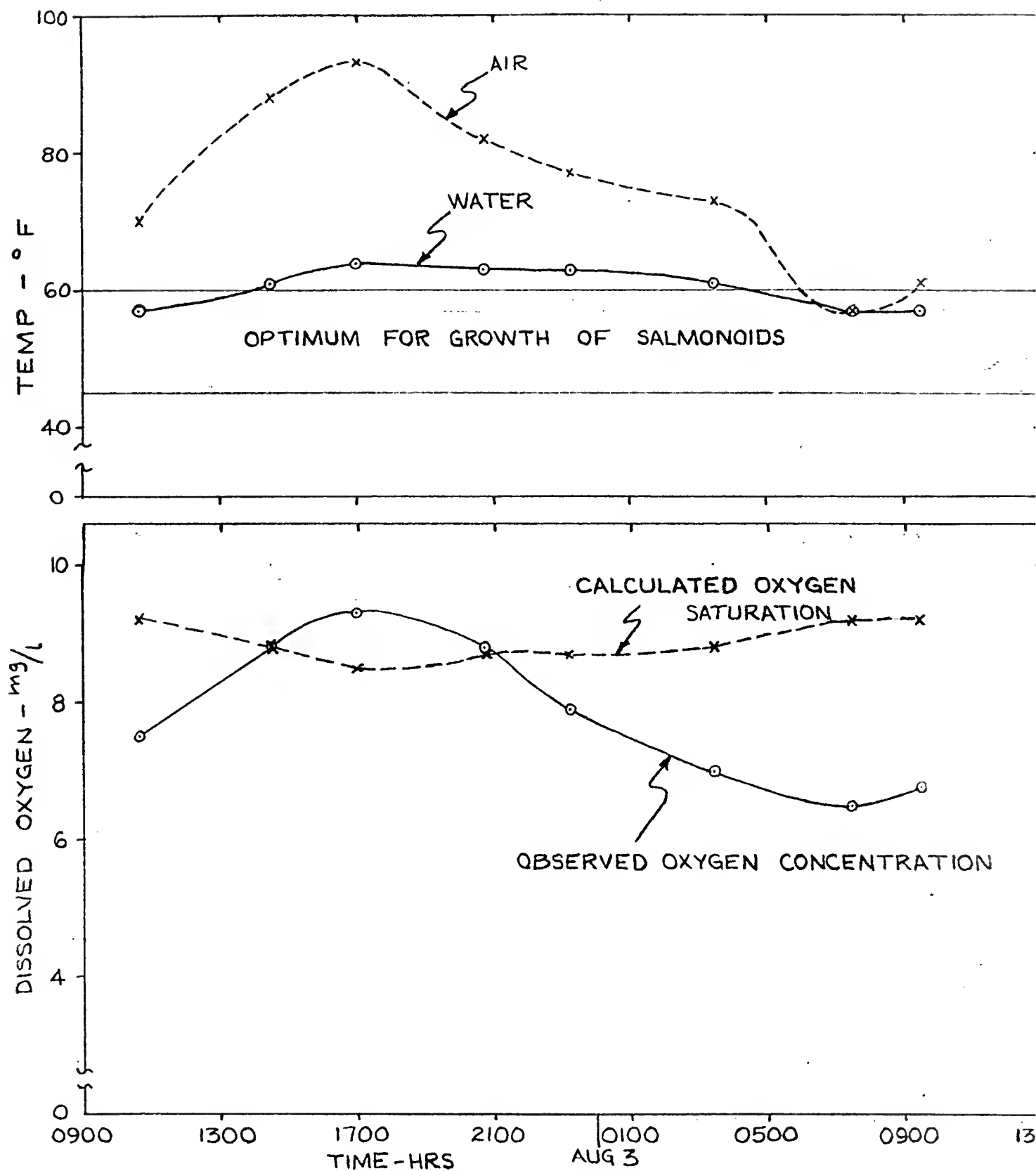


FIGURE 15. DISSOLVED OXYGEN AND TEMPERATURE DIURNAL VARIATIONS FOR CLARK FORK R AT HUSON

Aquatic invertebrates samples were collected and analyzed by the U. S. Environmental Protection Agency from the Clark Fork River at 12 locations from the city of Missoula to a point downstream of the city of Alberton. This sampling was done from July 23 to August 3, 1973. A summary of the sampling results above and below the mill is shown in Table 27.

The Ecological Consulting Service, under contract to H-W, performed a similar study at six locations from just below the Missoula sewage treatment plant to St. Regis. This study was done from July 13 to August 7, 1973. A summary of these results is shown in Table 27. These studies also included cursory examinations of algal populations.

Dr. C. C. Gordon, professor at the University of Montana, Missoula, Montana, collected rainbow trout from four locations on the Clark Fork River between October 17 and November 15, 1973. At this time, there was no direct discharge from the mill, and the river flow varied from 1860 to 4000 cfs. The flavor of these fish was tested by the Department of Food Science and Technology, Oregon State University. Results of these tests (Table 28) indicated fish from immediately below the sewage plant had a definite abnormal taste but fish from below the H-W mill tasted as good as control fish. A similar series of taste tests were carried out during the direct discharge period in 1973 by The Ecological Consulting Service under contract to H-W Corporation. The results of these tests were inconclusive, but indicated the direct mill discharges may affect the taste of fish. DHES, with the cooperation of the State Fish and Game Department, performed taste tests during May, 1974. For this test, rainbow trout were held in cages placed at three locations in the Clark Fork River. The three locations were:

1. Just above Harper's Bridge (three miles above discharge).

2. In the river about 300 yards below a side channel mouth (one mile downstream from discharge).
3. In the river about 3.5 miles below the discharge.

The flavor of these fish also was tested by the Department of Food Science and Technology of Oregon State University. The flavor and desirability of the fish held below the mill discharge were significantly lower than control fish (Table 29). At this time, the stream flow was about 15,000 cfs and the mill discharge was from about 44 cfs to 80 cfs.

Table 27

SUMMARY OF AVAILABLE BIOLOGICAL DATA

Year	Month	Sample Method	Above the mill		Below the Mill		Source
			Total #/ft ²	% Sensitive	Total #/ft ²	% Sensitive	
1973	July- August	Surber	535	30	1221	24	1
1973	July- August	Surber	253	61	828	51	2

1. EPA - 1973
2. Ecological Consulting Service - 1973

Table 29

RESULTS OF TASTE TESTS OF RAINBOW
TROUT HELD AT VARIOUS LOCATIONS IN
THE CLARK FORK RIVER FROM MAY 2, TO MAY 7, 1974

SCORE RANGES: 7 - No off-flavor to 1 - Extreme Off-flavor
7 - Very desirable to 1 - very undesirable

<u>Sample*</u>	<u>Off-flavor</u>	<u>Desirability</u>
A	6.1	5.5
B	4.76**	3.73**
C	4.84**	3.92**

* A - just above Harpers Bridge

B - At the Marcure Ranch

C - About 3.5 miles below the discharge

**Significantly different from the control at the one percent level

Table 28

RESULTS OF TASTE TESTS OF RAINBOW TROUT
COLLECTED FROM THE CLARK FORK RIVER BETWEEN
OCTOBER 17 TO NOVEMBER 15, 1973

SCORE RANGES: 7 - No off - flavor to 1 - Extreme off-flavor
7 - Very desirable to 1 - Very undesirable

<u>Sample*</u>	<u>Off-Flavor</u>	<u>Desirability</u>
A	6.37	5.67
B	5.05**	4.30**
C	2.27**	1.65**
D	6.07	5.42

*A - Above the Russell Street Bridge = used as a control

B - Between the Russell Street Bridge and Missoula sewage treatment plant (above Daily's Meat Plant)

C - Up to one mile below sewage treatment plant

D - UP to two miles below H-W plant

**Significantly different from the control at the one percent level

CONCLUSIONS

Based on available biological data, mill wastes increase total numbers of aquatic invertebrates and slightly decrease the percentage of sensitive forms in the Clark Fork River immediately downstream from the mill. These studies have not included adequate examinations of algal populations and algal productivity or of the biomass of aquatic invertebrates. No data are available on the effects of the H-W discharges on fish populations or productivity. Taste of fish from the Clark Fork River below H-W apparently is affected by present mill discharges only during the direct discharge period.

IMPACT OF WASTES ON WATER QUALITY

After expansion, waste flows and loads from the mill (Table 30) can enter the river via groundwater, as a direct discharge, or as a combination of the two. To evaluate potential effects on the river, several discharge conditions are considered. All calculated concentrations assume use of an aerated waste system and complete mixing with river water. Concentrations in the river from the existing disposal scheme are shown in Table 30 for

Table 30
CALCULATED INCREASE IN CONCENTRATION OF SELECTED PARAMETERS
IN THE CLARK FORK RIVER DUE TO DISPOSAL OF H-W WASTES⁺

7-day/10-year low flow (930 cfs)

Average annual flow (5448 cfs)

PARAMETER	DISPOSAL SYSTEM*	ALL SEEPAGE	DIRECT DISCHARGE	ALL SEEPAGE	DIRECT DISCHARGE	APPLICABLE WATER QUALITY STANDARDS**
BOD	2.65	0.41	0.10	0.07	0.10	none
TSS	0.79	0.0	0.15	0.0	0.16	none
TDS	15.0	65.6	10.1	11.6	10.1	500
Color	19.8	4.8	5.0	0.85	5.0	5 units increase
Sodium	3.4	9.8	1.51	1.74	1.52	none
Chloride	1.91	10.6	1.63	1.87	1.64	250
Sulfate	0.50	11.6	1.78	2004	1.79	250
Phenol	0.002	0.0006	0.0005	0.0001	0.0005	0.001
Phosphorus as P	0.001	0.012	0.002	0.002	0.002	none
Nitrogen as N	0. 0.028	0.079	0.015	0.014	0.015	10.1***
Discharge	15.8	21.6 mgd	3.23 mgd	21.6 mgd	18.9 mgd	

+All concentrations in mg/l (milligram/liter) except as indicated

*Assumes a 150:1 dilution ratio (River water to wastewater) for comparison purposes

**Montana Water Quality Standards, MAC 16-2.14(10)-S14480

***As Nitrate Nitrogen

comparison purposes. For the present disposal case a 150:1 dilution ratio is used for calculations and a direct discharge to the river is assumed.

CASE 1 ALL DISPOSAL BY SEEPAGE - STREAMFLOW 7 DAY-10 YEAR LOW (937 CFS)

This condition (Table 30) produces concentrations in river water that would not violate applicable water quality standards. Color at 4.8 CU (color units) is the parameter nearest the maximum limit. It is assumed in this case that an 85 percent color removal would occur in the groundwater system.

CASE 2 - ALL DIRECT DISCHARGE - 7-DAY/10-YEAR RIVER FLOW

The rate of direct effluent disposal to the river system would be limited by the allowable increase in stream color of 5 cu. Direct discharge in this case would be limited to 3.2 mgd (5.0 cfs).

It is apparent that at the 7-day, 10-year low flow, the entire plant effluent of 21.6 mgd (33.5 cfs) must be disposed of by seepage. A variety of combinations of seepage, direct discharge and storage would be used to meet stream water quality standards.

CASE 3 - ALL DISPOSAL BY SEEPAGE AT AVERAGE ANNUAL STREAM FLOW (5448 CFS)

In this case, no water quality standards would be violated.

CASE 4. ALL DIRECT DISCHARGE AT AVERAGE ANNUAL STREAM FLOW

This condition would result in a violation of color standards. A discharge of 18.9 mgd (29.3 cfs) or 88 percent of the plant daily effluent flow would be the maximum allowed if a 5 color unit increase in the river was adhered to. At a river flow of approximately 6225 cfs, the entire daily plant flow could theoretically be discharged directly to the river and not violate water quality standards.

None of the cases presented thus far has considered the large number of organic compounds common to kraft wastes. It is known that these compounds can produce tastes in fish flesh and can have significant biological effects.

Shumway (1966) and Shumway and Chadwick (1971) say that untreated Kraft wastes affect fish palatability at concentrations of 1-2 percent by volume in natural wastes and treated (aerated) kraft wastes affect fish palatability at 9 to 12 percent. These data suggest that the H-W mill wastes, after aeration, may have considerably less effect on fish palatability than at present. Biological effects of the many chemical compounds in kraft wastes are poorly known and bioassays using Guppies are normally taken to measure toxicity. Additional treatment (aeration) of H-W wastes will reduce waste toxicity; however, the amount of reduction is uncertain.

C. Social and Economic Considerations

The H-W pulp and paper mill has been a source of public controversy ever since its installation. On the one hand, the plant furnishes jobs for the community, and on the other hand it causes pollution problems serious enough to keep many persons from wanting to live there.

Although the company has spent much money on pollution control, the odor problem caused by the plant seems to the human nose to be as bad as ever, according to many residents. Accordingly, many persons are reluctant to see the mill expand until it is demonstrated that the pollution problems will not expand proportionately.

After H-W announced its expansion proposal in 1973, a group called the Concerned Citizens for a Quality Environment was formed. This group has been active in calling for further study of the proposed expansion. Within a period of approximately six weeks, approximately 7,000 persons signed the following CCQE petition.

TO: Governor Tom Judge
Lieutenant Governor Bill Christiansen
Dr. John Anderson, Director, Montana State Department of Health
and Environmental Sciences
Mr. Benjamin F. Wake, Director, Environmental Sciences Division,
Montana State Department of Health and Environmental Sciences

"We strongly request that you use your good offices to ensure that there be at least a two year delay in granting any permit for the proposed expansion of the Hoerner Waldorf facilities in Missoula County. We are very concerned about further potential environmental degradation (air, water and resources) which could ensue and believe that many questions must be answered before any permit is granted. In particular we feel that the proposed air monitoring system should show that the company will have complied with state standards for at least one full year. A comparable study of the water system is also a necessity. Finally, HW should be obliged to reduce its emissions to the low levels already achieved by comparable companies.

"The expansion of any facility in the Missoula Valley is something that will affect us for many years to come and careful, long-range planning is essential."

To further test public opinion in regard to the proposed expansion, a random telephone survey was taken in the fall. Of those sampled, 156 were in favor of the expansion, 195 were against, and 102 had no opinion.

ECONOMIC BENEFITS OF EXPANSION

There are at least two schools of thought as to how much the expansion would benefit Missoula. One school is led by Dr. Maxine Johnson, who was hired by H-W to assess the economic ramifications of the proposed expansion in the "Environmental Impact Statement" issued by H-W when it announced it would seek the expansion.

Basically, Dr. Johnson said that the expansion would offer significantly expanded high-wage employment opportunities to Missoula residents at little or no economic cost to the residences. The latest estimate of the expansion cost to H-W is \$60 million. The anticipated new employment at the mill would be 150 year round workers. The latest revision of the cost estimates is as follows, according to Dr. Johnson (21).

	<u>Revised Estimate</u>
Capital Expenditure	\$60 million
Construction Employment (no. of workers)	
1st First Year	450
Second Year	670
Construction Wages, Total	\$20.2 million
First Year	\$ 8.1 million
Second Year	\$12.1 million
Additional Property Tax Payments (Maximum)	\$1,934,000
Additional Expenditures for Chips, Sawdust & Logging Residuals	\$ 6.5 million
Additional Hogged Fuel Purchases	\$700,000'

Dr. Johnson said most of the jobs could be filled from the Missoula area. She said also that she did not expect the additional property tax

payments to reach the above figure. The company plans to request a Class 7 classification for the added valuation attributable to pollution control equipment, as shown below, and the large increase in total property valuation in the Frenchtown school and rural fire districts might result in reduced levies, according to Dr. Johnson. (21)

Air Pollution Control Facilities for Which Class 7 Tax Status Will Be Sought		Estimated Cost
A.	Sawdust digester non-condensable gas collection and direction to lime kiln for incineration.	\$ 45,000
B.	Existing brown stock washer hood exhaust collection and direction to recovery boiler combustion air system	35,000
C.	Existing washer filtrate foam tower vent collection and direction to recovery boiler combustion air system.	25,000
D.	New sawdust pulp washer hood exhaust and filtrate foam tower vent and direction to recovery boiler combustion air system.	50,000
E.	New black liquor concentrator system and building.	440,000
F.	New evaporator non-condensable gas collection and incineration.	30,000
G.	No. 2 recovery boiler conversion to controlled odor (extended economizer).	700,000
H.	No. 2 recovery boiler electrostatic precipitator	2,000,000
I.	No. 2 recovery dissolving tank vent scrubber	50,000
J.	Scrubbers on new hogged fuel boiler or flue gas desulfurization equipment on new gas-oil burner	500,000
K.	Lime kiln scrubber	75,000
L.	Tall oil scrubber	25,000
M.	Instrumentation & controls for odor abatement system	25,000
N.	Engineering	200,000
O.	Contingencies	<u>400,000</u>
TOTAL		4,600,000

Dr. Johnson wrote in the "Environmental Impact Statement":

"The overall effect might be a combination of a substantially increased tax base in the county and the school district, plus a possible reduction in levies for taxpayers in the Frenchtown area.

"Increases in the cost of public services provided to the mill are expected to be minimal. Heavier traffic on the county roads leading to the mill may result in larger maintenance costs. Fire protection will continue to be provided by the Frenchtown rural fire district. In both instances, the appropriate funds will receive increased revenue.

"The demand for public services on the part of the 300 potential new Missoula County workers and their families should not be burdensome. The modest number of people involved in relationship to total county population should create no particular hardship. Many of the jobs will be filled by current residents, perhaps some of those presently unemployed. Jobs in derivative industries, particularly trade and service industries, often are filled by women; these potential workers may already be in the community. Should new mill workers come from outside the county and locate in the Frenchtown area, as many have done in the past, that school district might experience some growing pains. However, the increased revenue to the district should more than take care of the added costs. The impact on Missoula's District I would depend upon the geographic location of workers' residences. In some areas of the city, public school enrollments are leveling off; in others overcrowding still exists.

"The possibility of some disruptive influence during and after the construction period, should the timing coincide with other large projects, has been referred to above.

"Probable increases in state and local tax collections from individual workers employed at the mill and in supporting industries and increases in corporate license tax payments by the corporation to the state of Montana have not been estimated.

"Some of the new workers may live outside the county; approximately 12% of Hoerner Waldorf's present employees do so."

In fiscal 1972, H-W paid \$276,659 in property taxes, including motor vehicle taxes. Of this amount, \$58,000 went to Missoula County, \$71,000 to the county school funds, \$5,000 to the library and city-county planning funds, \$110,000 to the Frenchtown school district, and \$22,000 to the Frenchtown rural fire district.

Two independent economists, Dr. Thomas M. Power and Dr. Malinda Schail, differ with Dr. Johnson regarding the actual economic impact of the

development. They wrote in part: (22)

"We wish to emphasize that we do not oppose the expansion of Hoerner-Waldorf or the wood-products industry. We argue instead that economic conditions are not so bad nor the benefit offered by an expanded pulp mill so great that Missoulians should be rushed into approving the expansion before its impact on the public resources of this valley is known as the environmental controls it plans to use to protect those resources are proven. We find the conventional optimism about industrial expansion and the conventional pessimism about Western Montana's economic situation dangerously misleading."

Power and Schaill summarized their critique of Dr. Johnson's economic assessment as follows: (23)

"1. The long-run employment impact (of the expansion) will not be as large as suggested. In addition, many of the projected high-wage jobs will not go to Missoula Valley residents if the expansion is allowed to proceed immediately. Local residents will fill the lower-paying (but above average) jobs. Possibly 100 jobs for local residents are at issue."

"2. As a result of the expected influx of almost 600 construction workers (and some of their families) into the area to build the plant and the expected migration of individuals from outside the area seeking high-wage jobs in a "high amenity" area, the actual employment situation in Missoula, as seen by current residents, may deteriorate. Competition for existing jobs may increase."

"3. The construction phase of the expansion may well feed a building boom already underway. The infant city-county planning agencies cannot yet be expected to help plan this growth. The result will be the irretrievable commitment of county land and space resources in a way that will have a negative impact on future social and economic patterns in the Missoula Valley."

"4. The Missoula Valley, when judged by national standards, is neither a low income area nor an area of retarded growth. This argument, therefore, should not be used to justify environmentally destructive growth."

"5. The estimated number of additional jobs indirectly created by the expansion is uncertain. NO real analysis lies behind the figure chosen in the impact statement."

"6. The expansion of Hoerner-Waldorf or the building of a new pulp and paper mill in the region seems a certainty. Given the unique locational advantages of the area, delaying the building of the plant will not mean that the region will lose the expansion. This means that there is the possibility for the region to "have its cake and eat it too," i.e., to obtain the additional incomes for existing residents at minimal environmental costs."

"7. A two to five year delay in the expansion is justified in terms of increased incomes for existing residents, more rational land-use

planning in the Missoula Valley, and reduced environmental costs (air and water pollution). There is no serious long-run cost associated with such a delay.

"8. Missoula and Western Montana's present and future growth is at least partially tied to its status as a high amenity region. To undermine this in the pursuit of questionable short-run gains may damage growth potentials in the future."

D. Wood Waste Supply

H-W's primary source of chips is residue from primary forest product wood processing plants. The two major manufacturing processes are sawmill and plywood operations.

Since the advent of the pulp and paper operations in Missoula County in 1957, the lumber and plywood industry has grown dramatically. Montana lumber production in 1957 was 832.2 million board feet generating a wood waste residue potential to produce 308 thousand BDUS* of chips. The plywood industry was in its infancy and was producing less than 50 million 3/8 inch square feet and could potentially produce 34 thousand BDUS of chips. There was a potential supply totalling approximately 342 thousand BDUS.

Montana sawmills in 1971 produced 1,397 million board feet and generated a potential of approximately 684 thousand BDUS of chips. This presents an increase in lumber production of almost 70 percent. Chip potential was increased 100%.

Plywood production in 1971 was 415.2 million 3/8 inch square feet and produced a potential of approximately 104 thousand BDUS of chips. This represents an increase of more than 700 percent in plywood production and about 206 percent in potential chip production.

As yields improve in plywood manufacturing the salvable wood for chipping will diminish. This is because of the type of technology applied to plywood manufacturing.

H-W's present production, rated at 1,100 tons per day for 350 operating days, will gross a total production of 385,000 tons of pulp and paper per year and require 668 thousand BDUS of chips. Factors that determine raw materials requirements are yeild, wood market trends, mix (chip and sawdust ratios) and other contingencies. H-W outlines its

*Bone-Dry-Units equivalent to 2400 pounds of oven dry wood.

present committed supply as 95.0 percent wood waste chips, 4.8 percent sawdust and 0.2 percent roundwood chips to produce 1,100 tons of pulp and paper.

Table 31

Production Committed to Hoerner-Waldorf Corporation that is
a Potential Source of Sawdust Residue Production (1971 Basis)

Operation	No. of Plants	MMBF Lumber Scale	MMBF 3/8" Sq. Ft.	Thousand BDUS		
				Chips	Sawdust	Total
Total All Sources	36			688	538	1,046
				--thousand short tons--		
Potential Yield of Kraft Pulp				396	200	602

Source: Directory of the Forest Products Industry, 54th Edition, Miller Freeman Publications, San Francisco, CA, and random sampling.

Forty-eight percent pulp and paper yield is an accepted recovery level for Montana wood species. The present pulping facility is capable of using wood chips from any conifer tree specie except western red cedar (*Thuja plicata*) within the area. Usable species include Douglas-fir, Western larch, Lodgepole pine, Englemann spruce, Eastern white pine, Ponderosa pine, and Alpine fir.

A study of the present chip supply potential committed to H-W encompasses plants with a production capability of approximately 636 thousand BDUS of chips per year. In order to balance fluctuations in chip flow due to market trends and other contingencies, H-W installed a Nicholson Utilizer that is capable of chipping 90 thousand BDUS per year.

The plant expansion proposes that the present capacity of 1,100 tons per day be increased to 1,850 tons per day. The expansion as outlined in Table 32 would require 1,124 thousand BDUS of chips and sawdust per year. H-W would utilize an additional volume of 187 thousand BDUS of sawdust and 50 thousand cords of roundwood per year. Markets for primary and secondary

wood products and competition for raw materials will ultimately determine the balance of other sources of supply that would be tapped.

Table 32

Proposed Expansion

	Annual Pulp & Paper Production tons/yr	Wood Usage BDUS/year
Present Mill 1,100 tons/day	385,000	668,400
Proposed Mill 1,850 ton/day	647,500	1,124,130

As planned, the expansion will utilize first the unused primary manufacturing wood waste residues (chips and sawdust). Next, depending upon forest practices, it is most likely that round slash wood waste accumulations from the annual harvest would be utilized. Finally, the readily accessible dead standing and down wood waste would be taken.

UNUSED PRIMARY MANUFACTURING RESIDUES

There is a significant change in pulp and paper raw material availability. The source of supply within Region I is rapidly increasing. The total source of chip supply from 54 primary manufacturing facilities will produce 1,654 thousand BDUS of chips and sawdust.

Table 33 projects the potential availability of manufactured chips and sawdust. The 49 Montana plants reviewed produce more than 95 percent of the total lumber from Montana in 1971. In 1971 sawdust made up about 37 percent of the potential BDU tonnage. By 1980 it will represent only about 25 percent of the potential tonnage. H-W studies show conclusively that it can utilize 20 percent sawdust for pulp in the production of linerboard and between 25 and 30 percent sawdust in the production of kraft sack paper.

Table 33

Pulp and Paper Raw Material Source Projection of Residues Within
Hoerner-Waldorf Corporation's Area of Influence (1971 Basis).

Operation	No. Plants	MMBF Lumber Scale	MMBF 3/8" sq. ft.	Thousand BDUS		Total
				Chips	Sawdust	
Total all Sources	55			1,137	607	1,744
				--thousand short tons--		
Potential Yield of Kraft Pulp				655	350	1,005

Source: Directory of the Forest Products Industry, 54th Edition, Miller
Freeman Publications, San Francisco, CA, and random sampling.

Also available to H-W will be logging slash and dead standing and
down timber.

LOGGING SLASH WOOD WASTE

The U.S. Forest Service estimates that the amount of wood fiber 4
inches in diameter and larger left each year on logged areas amounts to
7 million tons in Region I, alone. There are 11 national forests in
Montana and the total from the nine reporting show an annual logging slash
wood waste of 743,000 cords. There is no information available on Kaniksu
or Kootenai.

The Beaverhead, Bitterroot, Flathead and Lolo National Forests in close
proximity to Missoula, reported a combined total annual logging slash waste
of 541,000 cords. These four account for about 73 percent of the total
reported wood waste supply available.

The total wood waste is composed roughly of 56 percent chipping logs,
23 percent stud logs, 21 percent post and poles, and a few peeler blocks.

Table 34 indicates there is a total of 485 thousand BDUS of chips and
33 thousand BDUS of sawdust for a grand total of 518 thousand BDUS of
raw material readily available to manufacture pulp and paper. This is

enough raw material to produce 298,000 tons of pulp and paper per year, for exceeding the needs of the maximum proposed plant expansion.

Table 34

Annual Logging Wood Waste Supply Readily Available from 9 of 11 National Forests that are Wholly or Partially Within Montana's Boundaries (1971 technology)

Raw Material Classification	Thousand Cords	Percent	Chips	Sawdust	Total
Post & Poles	154	20.7	0.0	0.0	0.0
Stud Logs	171	23.0	36.8	33.1	69.9
Peeler Blocks	2	0.3	0.6	0.0	0.6
Chips	<u>416</u> 743	<u>56.0</u> 100.0	<u>447.3</u> 484.7	<u>0.0</u> 33.1	<u>447.3</u> 517.8

DEAD STANDING AND DOWN WOOD WASTE

The U.S. Forest Service reports 200.8 million cords of sound dead wood waste in the Bitterroot and Lolo National Forests contiguous to Missoula. These volumes do not include reserves classified as inaccessible or deferred areas. The Bitterroot National Forest accounts for 12.5 percent and the Lolo National Forest for 87.5 percent of the total 200.8 million cords, a wood waste accumulation that presents a delicate fuel management problem. The wood waste accumulation is composed of roughly 42 percent Lodgepole pine, 20 percent Alpine fir, 10 percent Douglas-fir, 10 percent larch, 10 percent Grand fir, 7 percent Engelmann spruce and 1 percent other species. The lodgepole specie classification includes some white bark pine and limber pine.

Access roads are adjacent to about 10 percent of the supply in the Bitterroot National Forest and between 15 to 20 percent of the inventory in the Lolo National Forest; therefore, it can be conservatively estimated that main access roads are in place to readily extract 30.1 million cords.

It is estimated that this wood waste is composed of 21.5 million cords of

chipping logs, 6.1 million cords of sawmill logs and 2.5 million cords of post and poles. Table 35 indicates that 24.4 million BDUS of chips and 1.2 million BDUS of sawdust is readily available for pulp and paper manufacturing. There is enough raw material available in the Bitterroot and Lolo National Forests' non-reserved (excluding deferred) area to produce 737,000 tons of pulp and paper per year for 20 years, although this accounts for less than 15 percent of the total dead standing and down wood waste accumulated in these two contiguous forest areas.

Table 35

Total Dead Wood Waste Supply Readily Available from the Bitterroot and Lolo National Forests (1971 technology)

Raw Material Classification	Million Cords	Percent	Million BDUS		
			Chips	Sawdust	Total
Post & Poles	2.5	8.3	0.0	0.0	0.0
Sawmill Logs	6.1	20.3	1.3	1.2	2.5
Chipping Logs	<u>21.5</u> 30.1	<u>71.4</u> 100.0	<u>23.1</u> 24.4	<u>1.2</u>	<u>23.1</u> 25.6

SUMMARY OF WOOD WASTE SUPPLY

There is an ample supply of raw material for expansion. Table 35 indicates that there is a total supply in the Missoula area readily available to support the H-W mill expansion. Markets for primary and secondary wood products and competition for raw material will ultimately determine the source of supply that will be tapped. Sawdust will continue to be used for fuel to generate energy by some companies, so not all sawdust in the summary analysis is available at this time. If the value structure changes, sawdust could be available for pulp. Wood waste from stand improvement thinnings is not considered in this proposal or future accumulation from natural causes.

E. Vegetation

The vegetation in the vicinity of the H-W mill is dominated by the Douglas-fir, ninebark habitat-type as described by Daubenmire (24). Much Ponderosa pine is present at the lower elevations of the mountain slopes. Deciduous trees are found in the riparian communities along the Clark Fork River. Here cottonwoods and willows grow. EPA and the Air Pollution Control Association have ranked Douglas-fir and Ponderosa pine as relatively sensitive to SO₂ (25, 26).

Sulfur dioxide damage on these trees appears variously as chlorosis, tip necrosis and banding, depending on the exposure length and concentration (26, 27). The damage is attributed to the toxic sulfite ion which results from the oxidation of SO₂ once it enters the plant (28).

Sulfur damage to vegetation in the H-W vicinity was first observed in 1963 by Gordon (29). The damage symptoms included necrosis on Ponderosa pine and Douglas-fir. These acute symptoms, though most frequent in areas west of the mill were found up to ten miles northwest and south of the mill. The damage on Douglas-fir increased drastically during the winter of 1973, at which time Clinton Carlson of the U.S. Forest Service initiated an in-depth study of the problem (8). The most severe sulfur type damage occurred quite close to the plant so his study was restricted to an area within three miles of the pulp mill and directly west. This area ranged in altitude from 3100 to 3800 feet.

Sulfur emitted by H-W is in the form of both reduced sulfur compounds and sulfur dioxide. The daily emissions include 520 lbs. of reduced sulfur and 5000 lbs. of SO₂. In the winter of 1972-73, H-W increased its sulfur emissions when it switched from burning natural gas to fuel oil. Company officials have indicated that this additional SO₂ possibly

raised the levels emitted by the pulp mill to thresholds believed to be toxic to vegetation.

The symptoms observed on Douglas-fir by Carlson during the winter of 1973 included tip necrosis, banding, and needle casting. The damage syndrome appeared to progress from the inside of the crown outward and from the bottom of the tree upward. Aerial infrared photography of the region showed 1240 acres of Douglas-fir severely damaged, 1120 acres moderately damaged and 2840 acres lightly damaged.

Carlson's study of the area included establishment of 20 observation plots, on each of which two Douglas-fir and one Ponderosa pine were chosen for:

1. An assessment of extent damage.
2. Total sulfur analysis.
3. Histological preparations.

The area was monitored for sulfur oxides using sulfation plates and bubbler samplers (30). Soil samples also were collected for analysis. Insect larvae were collected to determine if an infestation was present. The data from the H-W vicinity was compared with data taken from control plots in Twin Creeks and Plains Montana which are 20 miles and 100 miles distant from H-W, respectively.

Carlson's study implicated H-W a cause of damage to the timber in the vicinity. With Douglas-fir, damage severity correlated with increasing sulfation rates. The excessive sulfur content of these severely damaged trees was significantly higher than that of trees growing on control plots. (Table 36). The sulfur content of tissue from each damage category (light, moderate, severe) differed significantly from control tissue. This sulfur content of Douglas-fir increased as the amount of oxidizable sulfur in the ambient air increased during July/August. This is worthy of note since the metabolic rate of these plants would be greatest during

Table 36

Statistical Significance of Means for Different Variables
by Damage Class, Douglas-fir and Ponderosa Pine

	<u>Control</u>	<u>Light</u>	<u>Moderate</u>	<u>Severe</u>
Needle Loss	2.81	<u>2.63</u>	<u>2.41</u>	2.20
Symptoms	.11	<u>.20</u>	<u>.22</u>	.36
Total Sulfur (DF)	<u>.03^{1/}</u>	.18	.22	.29
Total Sulfur (PP)	.01	<u>.09</u>	<u>.12</u>	<u>.12</u>
Sulfation Rate	.09	<u>.96</u>	<u>1.17</u>	1.52
Average Plot Distance from Mill		<u>2.75</u>	<u>2.36</u>	1.86
Average Plot Difference in Elevation		<u>383</u>	<u>407</u>	<u>525</u>

Means not underscored by the same line are significantly different at the 95 percent level.

1/ Percent sulfur based on the dry weight of the tissue.

the summer. Trees are most susceptible to air pollution damage during their period of greatest metabolic activity. Total sulfur in Douglas-fir foliage decreased with increasing distance up to 3.5 miles from the pulp mill (Fig. 16), although this sulfur content was still considerably greater than that found in control plots.

Histological work on Douglas-fir showed the typical syndrome of S damage (8). There was an indication of progressive breakdown of mesophyll parenchyma tissue beginning with granulation of chloroplasts, then plasmolysis and collapse of the cell. Hypertrophy of phloem tissue was observed in more severely damaged tissue. In the final stages the endodermis collapsed.

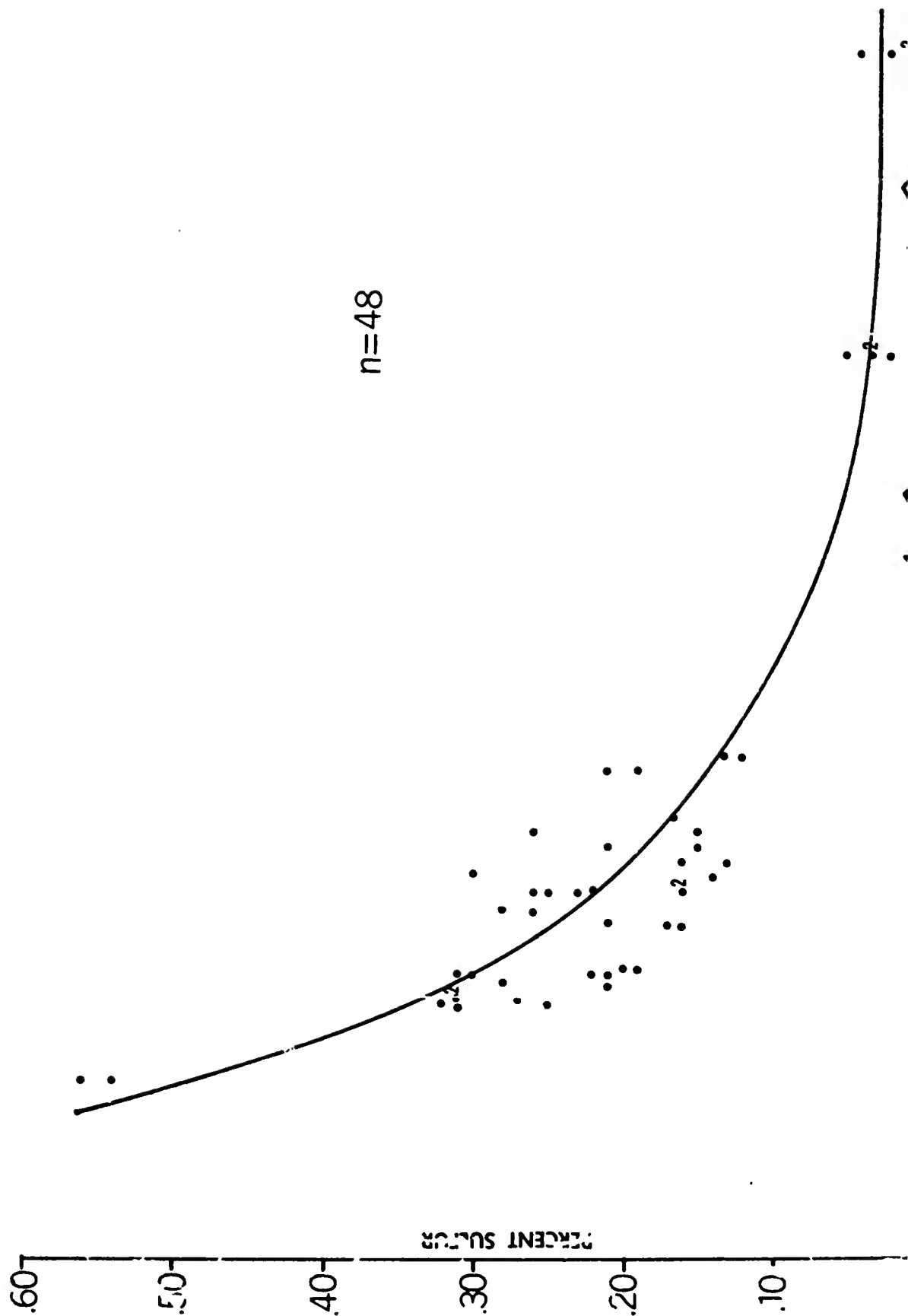
Little damage was found on Ponderosa pine growing with Douglas-fir within the study area. It has been documented that Ponderosa pine is not as sensitive to SO_2 as is Douglas-fir (31).

An entomologist, Mark D. McGregor, examined the insect larvae collected from the conifers sampled. The study indicated the presence of a negligible number of spruce budworm and tussock moths in the affected area, discounting these agents as significant contributors to the damage.

The U.S. Forest Service bubbler samples indicated SO_2 levels as high as 0.04 ppm for 1 hour during the period of the study. No monitoring of the area was conducted during the time when the damage is thought to have occurred as it is possible that this level was greatly exceeded at that time. This is plausible, considering the winter inversion frequency and presence of additional SO_2 from fuel oil combustion at the mill.

The Ecological Consulting Service of Helena conducted a study similar to Carlson's of damage to Douglas-fir and Ponderosa pine in the H-W

FIGURE 16 Relationship of Percent Sulfur in Douglas-Fir to Distance From Pulp Mill, Miles



vicinity (32). The field investigation was designed "to be complementary to a study being done by the U.S. Forest Service." According to ECS, the study included wind direction velocities, histology of Douglas-fir and Ponderosa pine needles, analysis of sulfur concentrations and estimation of percent needle loss.

The area was divided up into three altitudinal zones:

1. A low zone up to 3600 feet
2. An intermediate zone from 3600-4000 feet
3. A high zone from 4000 feet and above

The affected area where damage had been observed was divided into angular segments. Thirteen sites were chosen from these segments so as to complement the site locations of the U.S. Forest Service study. In addition, data were collected from control sites proximal to those of the U.S.F.S. in Plains.

At each site one Ponderosa pine and two Douglas-fir were chosen. Diameters were measured and cores were taken from each tree. Branches were collected from mid-crown. In addition, needles were separated and stored for sulfur analyses and histological preparations.

Results of this project showed that winds blew toward the study area from H-W 34.4% of the days observed. There was a significant difference between the sulfur content of the study area needles and those of the control area. Also the older needles of Douglas-fir reflected a significantly greater amount of total sulfur than did the one-year-old needles. The levels of ambient sulfur compounds in the study area were significantly higher than that of the control area.

The study concluded that besides a significant buildup of sulfur in needles from the H-W vicinity there was a higher percent loss of needles for Douglas-fir. Also, histological preparations indicated the presence of SO₂ type injury on Ponderosa pine tissue.

Both the Ecological Consulting Service and U.S. Forest Service findings furnish evidence that the H-W paper and pulp mill has damaged trees west of the mill.

An air monitoring program was implemented by H-W at the request of the Air Quality Bureau. Monitoring of the area indicated a peak concentration of 0.05 ppm SO₂ for a three hour period, and a peak H₂S level of 0.24 ppm. To date no violations of the state SO₂ standard have been monitored in the H-W vicinity. Besides H₂S and SO₂, mercaptans are given off by the pulp mill. The situation seems to be one of frequent low level fumigations, with the impact primarily to the west of the mill in the heavily forested area.

No experimentation results of consequence are available on the effects of H₂S or mercaptans on vegetation either alone or in combination with SO₂. Therefore it cannot be determined whether the damage to vegetation in the vicinity of H-W is the result of SO₂ alone or in combination with other mill emissions.

SDHES has sampled vegetation growing in the vicinity of H-W for sulfur content and damage symptoms. Needles were collected from Douglas-fir growing NW and SE of the mill. The sites were selected after taking into account the presence of sensitive species and the predominant wind patterns as indicated by data from the Rock Creek meteorological station. The trees were ranked for damage, and total sulfur analyses were made on 1973 needles using a Leico sulfur analyzer. The analyses indicated excessive S in Douglas-fir within three miles of the H-W mill (Fig 17). The levels of sulfur drop off rapidly as does the damage severity with distance from the Mill (Fig.18). Sulfur damage symptoms, tip necrosis, banding, chlorosis and needle casting, were observed on Douglas-fir up to 7 miles northwest of the mill. Where severe, the damage progressed

FIG. 17 Sulfur content (% dry wt) in Douglas-fir 1973 needles/miles from Hoerner Waldorf pulp mill

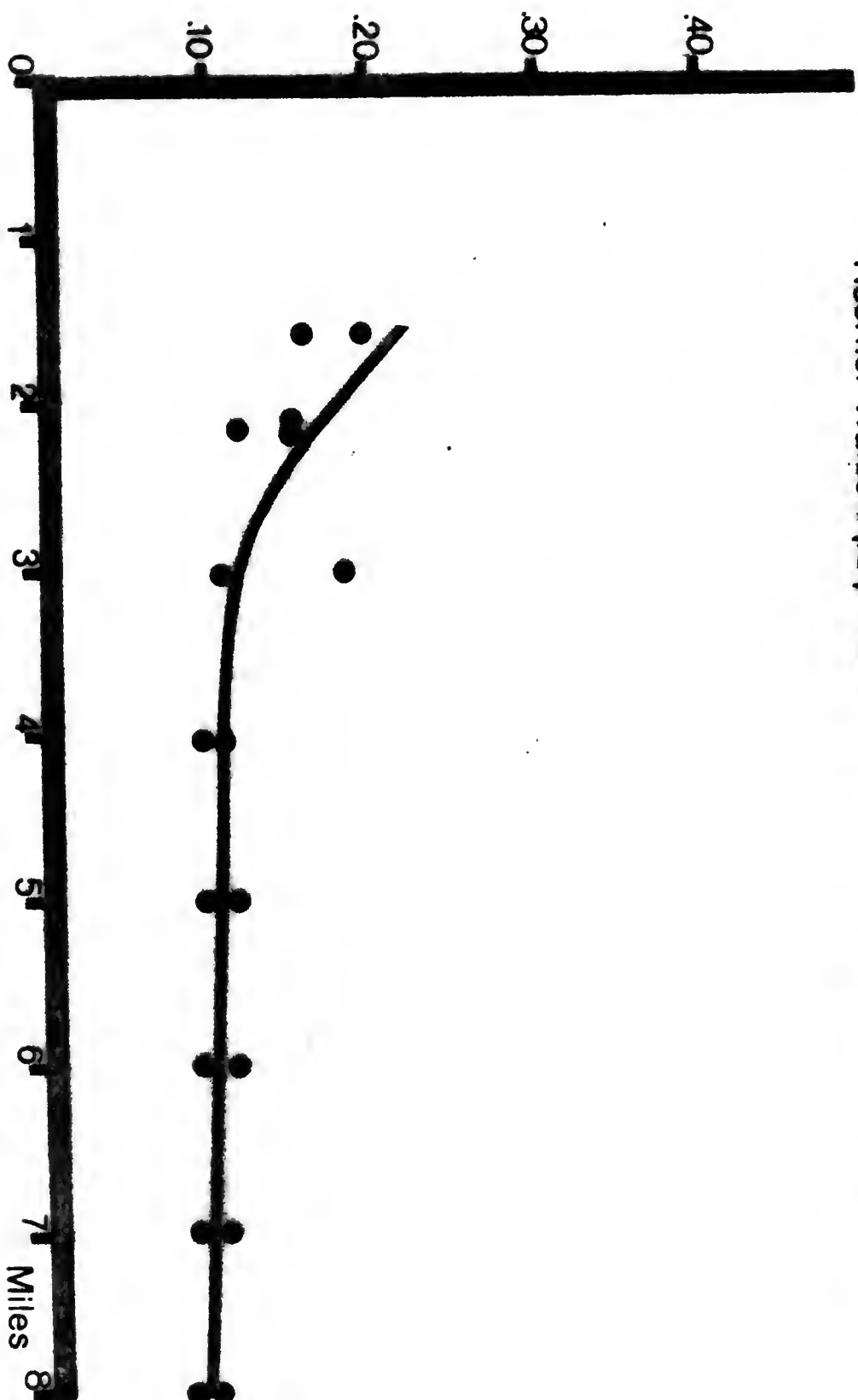
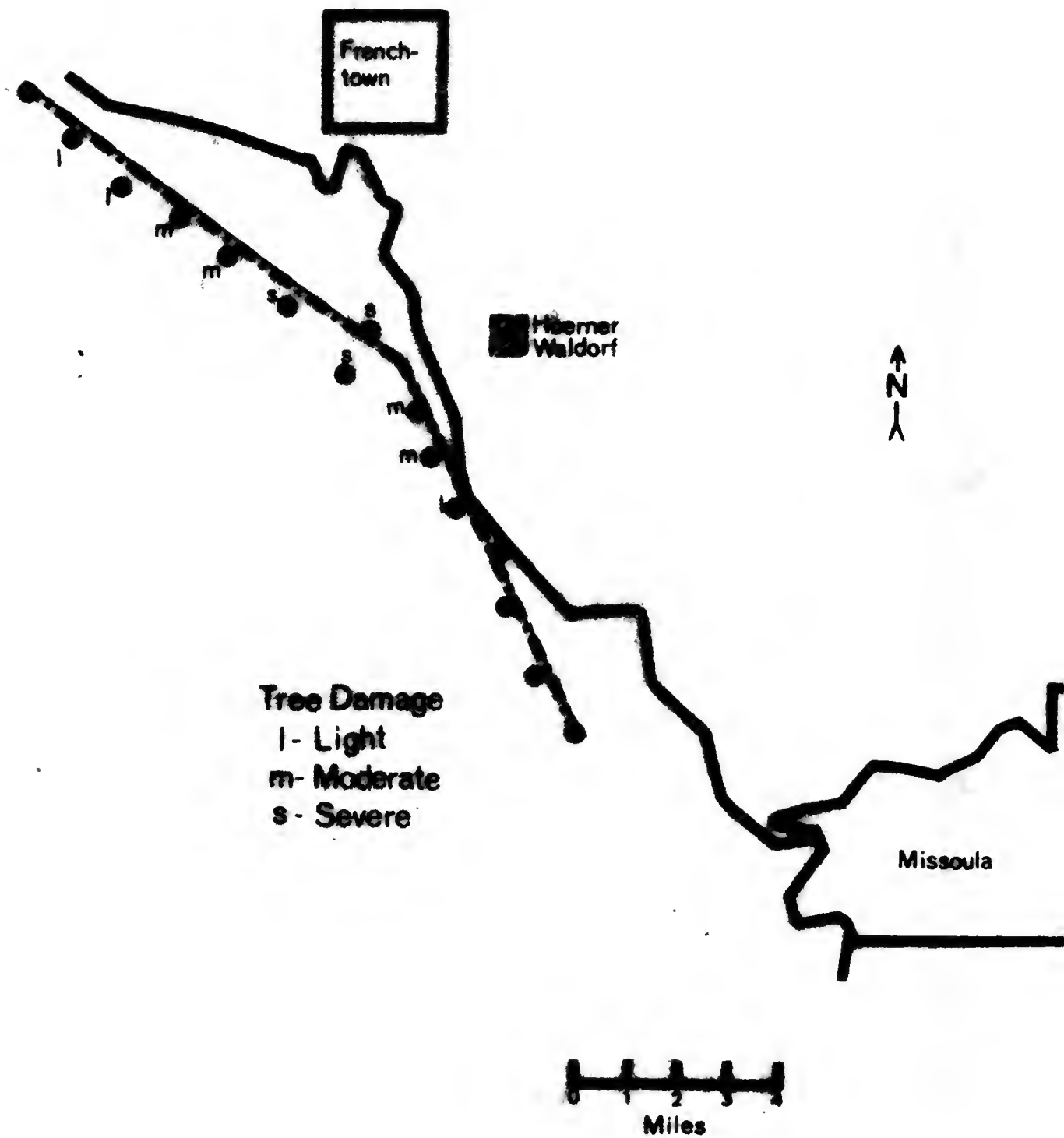


FIG. 18 Location of SDHES vegetation sampling sites



from the inside outward and from the bottom of the tree upward. Chlorosis was the prevalent symptom on the damaged trees beyond five miles from the mill. These findings agree well with those of Carlson and Gordon.

The type of damage syndrome noted in Douglas-fir forests adjacent to the H-W mill is further noted in other reports in the literature. A similar syndrome was documented by Scheffer and Hedgecock (31). The symptom appearance, symptom development, age of the sensitive tissue, species sensitivity and damage distribution which they reported in their smelter study all correlate with the findings of Carlson, Gordon, ECS and the SDHES concerning sulfur damage to trees in the vicinity of H-W.

H-W has stated that even with the proposed expansion SO₂ emissions will not exceed the present 5000 lbs/day. There is evidence of chronic sulfur injury to plants occurring in the Douglas-fir forests immediately west of the mill even at this emission rate. During the winter of 1973 when it appears the acute damage occurred, the emission rate may have been much greater than 5000 lbs/day of SO₂ according to the company officials.

Dr. Cokelet in his section of the "Environmental Impact Statement" for the proposed H-W expansion (1973) has indicated that the highest levels of SO₂ would be expected during the winter months. He maintains that due to dormancy the trees would be resistant to the SO₂ emissions. Carlson (1974) attributed the damage to Douglas-fir as having occurred during the winter of 1973. The warm chinook conditions which occur during the winter months in Montana, differ considerably from the winter conditions found in Sudbury Ontario which Cokelet cites. The phenomenon of winter injury (33,34) to conifers which is prevalent in the northwest chinook zone results from increased evapo-transpiration and increased metabolism during warm winter spells. In Montana the warm chinooks induce metabolism, and make conifers susceptible to SO₂ damage.

CONCLUSION

Evidence of sulfur damage to vegetation in the vicinity of H-W has come from several sources: the U.S. Forest Service, Ecological Consulting Service, the Botany Department of the University of Montana, and the State Air Quality Bureau. These sources indicate that:

1. SO₂ sensitive plants are present in the H-W vicinity.
2. SO₂ type injury is visible on these plants as both acute and chronic damage.
3. SO₂ type damage and abnormalities are present in the tissues of these plants.
4. Excessive S has been accumulated by the plants.
5. The damage is not of the type associated with pathogenic fungi or insects.
6. A source of potentially hazardous SO₂ is present.

It cannot necessarily be concluded, however, that the damage resulted from sulfur emissions in the form of SO₂. Monitoring in the area to date has shown that the SO₂ levels are lower than those which have been associated with vegetation injury (EPA, 1973) (25). Excessive H₂S and mercaptans are emitted by H-W in addition to sulfur oxides. These H₂S concentrations from the ponds and stacks greatly exceed the SO₂ emissions. Where experimentation has been conducted with H₂S alone, little injury occurred to the most sensitive plants using concentrations as high as 40 ppm (26). It is possible that the damage occurring to vegetation resulted from these other H-W emissions in combination with SO₂. Perhaps current experimentation being conducted by the U.S. Forest Service in Missoula will clarify this. Certainly the profuse growth in the H-W vicinity of lichens which reportedly are quite sensitive to SO₂ (35,36,37)

supports the hypothesis that the vegetation damage cannot be attributed to SO₂ alone.

IV. ACTIONS AVAILABLE TO SDHES

A. Statutory Authority

The statute (69-3911) provides that upon acceptance of a permit application, SDHES must decide whether and/or in what form the permit will issue. There are three available options: issue the permit as requested, deny the permit, or issue a conditional or modified permit.

By-the authority of the statute, the Board of Health adopted a regulation regarding permits establishing the practices and procedures to be followed. Subsection 12 of regulation 16-2.14(1)-S1400 specifies the criteria for a decision on a permit application as follows:

The director shall deny an authority to construct, or permit to operate or use, except as provided in this regulation, if the applicant does not show that every article, machine, equipment or other contrivance, the use of which may cause the issuance of contaminants, or the use of which may eliminate or reduce or control the issuance of air contaminants, is so designed, controlled, or equipped with such air pollution control equipment, that it may be expected to operate without emitting air contaminants in violation of standards and regulations formulated under authority of the Clean Air Act of Montana.

The Board realized that situations would arise wherein it could not definitively be established whether compliance would be attained and it provided for such occasions as follows:

The director may issue an authority to construct or a permit to operate or use, subject to conditions which will bring the operation of any article, machine, equipment or other contrivance within the standards of this regulation, in which case the conditions shall be specified in writing. Commencing work under such an authority to construct or operation under such a permit to operate shall be deemed acceptance of all the conditions so specified. The director shall issue an authority to construct or a permit to operate with revised conditions upon receipt of a new application, if the applicant demonstrates that the article, machine, equipment or other contrivance can operate within the standards of this regulation under the revised conditions.

Conditions which might be attached to a permit are many and varied, and might relate to: materials of construction; design options such as addition of more equipment; results of performance tests; operating parameters such as temperature, pressure, flow rate; and ambient air monitoring.

V. ENVIRONMENTAL IMPACTS OF ACTIONS AVAILABLE TO THE DEPARTMENT

A. If the Permit Were Denied

If the construction permit were denied there nevertheless would be a decline in emissions from the ponds, as a result of the aeration system now under construction. The extent to which emissions would be reduced is uncertain, but it appears the reduction would be at least 90 percent of the minimum of 17,000 pounds of H_2S now coming from the ponds daily.

Inasmuch as the impacts of the pond emissions are not known, it is not possible to predict what effects would result from the planned reduction of the emissions. Considering the low odor threshold of H_2S , methyl mercaptan, and some of the other odorous gases coming from the ponds, it is likely that the odor problem would persist, although with fewer and less intense episodes. A change in odor would be evident, as hydrogen sulfide odor was replaced by the odor of mercaptan compounds. Restricted visibility within the Missoula Valley would remain unchanged since many small particles would still be emitted into the valley air.

The various impacts believed to result from air emissions are discussed earlier in this statement.

Existing environmental impacts from liquid discharges are as follows.

1. There is some reduction of dissolved oxygen by the discharge of wastewater into the Clark Fork River during the spring run-off. Dissolved oxygen in the river during discharge is maintained above 2 mg/l; however, any reduction of DO from that naturally occurring may be detrimental to some forms of aquatic life.
2. Color standards are presently exceeded during the direct discharge of effluent to the Clark Fork River. During low flows in the river, there is noticeable color along the river bank near the ponds and immediately below the ponds.
3. There is a taste and odor in fish flesh during direct effluent discharge to the river. This taste and odor problem also may occur in the immediate vicinity of the mill during periods of low stream flow.

4. Foaming may be a problem in the river downstream from the plant, particularly below dams during periods of high stream flow and direct effluent discharge to the river.
5. Substantial odors are produced by the ponds.
6. There might be a threshold odor problem if water were taken from the river and treated for a domestic water supply.
7. About 745 acres of land have been removed from agricultural usage due to the ponding system.
8. The shallow aquifer underlying the effluent storage ponds contains considerable seepage water from the pond system. Pond wastes have also entered the deep aquifer in the vicinity of the plant. The quality of percolated wastewaters is significantly inferior to natural groundwater.

B. If the Permit were Granted as Requested

If the permit were granted and the plant expanded, air pollution would decline from present levels, but would be greater than if the plant were not expanded. SO₂ emissions would increase above the present levels, but diffusion modeling does not indicate that there would be violations of the SO₂ standards. Visibility could be decreased if the plant were expanded.

Impacts that would result from the liquid discharges of the expanded plant are as follows.

1. Discharge of wastes into the river will cause a small reduction of oxygen concentration in the river.
2. During low flows in the river, there will be noticeable color along river banks near the ponds and immediately below the ponds. Color due to mill effluent should not violate state water quality standards downstream from the mixing zone. If rapid infiltration disposal is used totally, total color entering the river will be greatly reduced as compared to use of direct discharge.
3. The potential for a taste and odor problem in a domestic water supply, if taken from the Clark Fork River below the mill, cannot be accurately assessed. Literature on taste and odor of fish flesh indicates that this parameter will not be a problem.
4. There will be odors associated with the sludge ponds.
5. Nutrients will be added to the water system to improve the biological treatment. Phosphates reaching the river will probably increase. This may cause a slight increase in biological activity in the river.

6. Through in-plant reduction of chemical losses and biological treatment, foaming potential of the wastewaters should be decreased.
7. An additional area of 345 acres may be removed from agricultural use for effluent disposal.
8. The shallow aquifer underlying the effluent storage ponds will contain considerable seepage water from the pond system. Pond wastes will continue to enter the deep aquifer in the vicinity of the plant. The quality of percolated wastewaters is significantly inferior to natural groundwater. A larger volume of wastewater may
b be discharged to the groundwater. The possible lateral extent of groundwater alteration cannot accurately be predicted, but is thought to not extend significantly beyond the boundaries of the mill property.

VI. CONCLUSION

From the preliminary information now available, it appears that H-W could expand its mill as proposed while reducing present emissions and discharges to comply with state air and water pollution standards. It appears that the expanded mill could then operate within the standards.

If further analyses of information obtained by this and other departments, by the public and by H-W strongly indicate that standards could be met by the expanded mill in its proposed configuration, the requested construction permit could issue. If on the other hand the information indicated that the standards could not be met by the expanded plant, the permit would not be issued, or would be issued contingent to certain conditions intended to assure that the expanded plant could and would operate within standards.

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GLOSSARY

Foul Condensates - Water with entrained sulfides and mercaptans, etc., condensed after evaporation from evaporators and concentrators

Air Stripping - Bubbling air through contaminated water to remove entrained gases

Hog fuel - Wood waste that has been ground up (hogged) to be used as a fuel

Total Reduced Sulfur (TRS) - Hydrogen sulfide, mercaptans, dimethyl sulfides, dimethyl disulfide and other organic sulfides

Aerobic - Processes in the presence of oxygen

Anaerobic - Processes in the absence of oxygen

A P P E N D I X A

AIR QUALITY REGULATIONS

Ambient air standards were developed to limit pollutant levels in the ambient air to a concentration low enough to protect health and property.

The emission standards restrict the quantity of pollutants a source can emit. They are as a general rule intended to require achievement of the "state-of-the-art" in pollution control.

Several ambient and emission regulations apply to H-W's proposed expansion. H-W is subject to two particular regulations; the S1430 "process weight" and S1450 "the particulate from fuel burning" regulations. Both limit particulate emission on a basis of the amount material used; the former on the total quantities processed, the latter on the total fuel burned. Reduced sulfur emissions (TRS) are regulated by S1470, Section 3, kraft pulp mills. This rule restricts emission of reduced sulfur to 17.5 ppm in the recovery furnace flue gases or to 0.087 #TRS/1000 lbs. of black liquor fired. Section (1) of this same regulation limits the amount of sulfur in fuel burned in a combustion device. Visible emissions are restricted by S1460, applicable to all sources in the mill. The state has adopted ambient air standards for sulfur dioxide, hydrogen sulfide, suspended particulate matter, and suspended sulfates. The numerical values are discussed in Section IIIA Air Quality.

A P P E N D I X B

WATER QUALITY LAWS, REGULATIONS, AND COMPLIANCE SCHEDULES

APPENDIX B

APPLICABLE FEDERAL AND STATE LAWS, REGULATIONS, AND COMPLIANCE SCHEDULE

PROPOSED EFFLUENT LIMITATIONS ON THE EPA DISCHARGE PERMIT (As of May 29, 1974)

IMMEDIATE EFFLUENT LIMITATIONS

During the period beginning immediately and lasting through July 14, 1975, the permittee is authorized to discharge from outfalls serial numbers 001, 002, 003, and 004, and by controlled seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, and 003 (direct discharge)

There shall be no discharge from these outfalls except during the spring high flow period. Discharges shall not commence until written permission is given by the Montana Department of Health and Environmental Sciences. Discharge shall be terminated when requested orally or in writing by the Montana Department of Health and Environmental Sciences.

Specific discharge requirements following the granting of permission to discharge are as follows:

1. 96-hour TL₅₀ - The combined rate of direct discharge shall not exceed the following formula:

$$\begin{array}{rclclcl} \text{Rate of waste} & (96\text{-hr TL}_{50} \text{ of the wastewater}) & & \text{River Flow} & 0.02 \\ \text{discharge} & = (\text{expressed as a decimal}) & \times & & \times \end{array}$$

where rate of discharge and river flow are in the same units; if contribution is from more than one pond, discharge rate shall be proportioned according to TL₅₀ results and contributing flow from the respective ponds.

2. In addition to the above requirements, the Montana Department of Health and Environmental Sciences may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharged through outfall 004 shall consist entirely of uncontaminated cooling water and shall not exceed 90° F.

Controlled Seepage

Controlled seepage shall achieve not less than 85 percent removal of BOD₅ in the wastewater seeping to the river.

INTERIM EFFLUENT LIMITATIONS

During the period beginning July 15, 1975 and lasting through February 28, 1977, the permittee is authorized to discharge from outfalls serial number 001, 002, 003, and 004, and by controlled seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, 003 and Controlled Seepage

There shall be no discharges from outfalls 001, 002, and 003, except during the spring high flow period. Discharges shall not commence until written permission is given by the Montana Department of Health and Environmental Sciences. Discharges shall be terminated when requested orally or in writing by the Montana Department of Health and Environmental Sciences.

Specific discharge requirements following the granting of permission to discharge are as follows. Whichever limitation provides the most stringent control shall govern.

1. 96-hour TL₅₀- the combined rate of direct discharge shall not exceed the following formula:

$$\begin{array}{lcl} \text{Rate of waste} & (96\text{-hour TL}_{50} \text{ of the wastewater}) \times \text{River Flow} \times 0.02 \\ \text{discharge} & = (\text{expressed as a decimal}) \end{array}$$

where rate of discharge and river flow are in the same units; if contribution is from more than one pond, discharge rate shall be proportioned according to TL₅₀ results and contributing flow from the respective ponds.

2. The combined spring discharge shall not contain more than 2,000,000 pounds of suspended solids.
3. Total annual discharge of BOD₅ in the direct discharge and controlled seepage combined shall not exceed 3,625,000 pounds.
4. pH - pH of the discharge shall be within the range of 6.0 and 9.0.
5. There shall be no discharge of floating solids or visible foam in other than trace amounts.
6. In addition to the above requirements, the Montana Department of Health and Environmental Sciences may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharge through outfall 004 shall consist entirely of uncontaminated cooling water and shall not exceed 90°F.

FINAL EFFLUENT LIMITATIONS

During the period beginning March 1, 1977 and lasting through June 30, 1979, the permittee is authorized to discharge from outfalls serial number 001, 002, 003, and 004, and by controlled seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, 003 and Controlled Seepage

There shall be no discharges from outfalls 001, 002, and 003, except during the spring high flow period. Discharges shall not commence until written permission is given by the Montana Department of Health and Environmental Sciences. Discharges shall be terminated when requested orally or in writing by the Montana Department of Health and Environmental Sciences.

Specific discharge requirements following the granting of permission to discharge are as follows. Whichever limitation provides the most stringent control shall govern.

1. 96-hour TL₅₀ - The combined rate of direct discharge shall not exceed the following formula:

$$\begin{array}{l} \text{Rate of waste} \quad (96\text{-hour TL}_{50} \text{ of the wastewater}) \times \text{River Flow} \neq 0.02 \\ \text{discharge} \quad = (\quad \text{expressed as a decimal} \quad) \end{array}$$

where rate of discharge and river flow are in the same units;
if contribution is from more than one pond, discharge rate shall be proportioned according to TL₅₀ results and contributing flow from the respective ponds.

2. Color - The combined rate of direct discharge shall also not exceed the following formula:

$$D = \frac{(Q)(3)}{Cd - (Cr+5)} \quad \text{where:}$$

D is the rate of discharge in cfs
Q is the river flow in cfs
Cd is the color of the discharge in SCU
Cr is the background color of the river in SCU

3. BOD₅ - The combined rate of direct discharge shall also not exceed the following formula:

$$D = \frac{2.5Q}{Cp-5} \quad \text{where:}$$

D is the rate of discharge in cfs
Q is the river flow in cfs
Cp = concentration of BOD₅ in the discharge in mg/l

4. The combined spring discharge shall not contain more than 2,000,000 pounds of suspended solids.
5. Total annual discharge of BOD₅ in the direct discharge and controlled seepage combined shall not exceed 3,625,000 pounds.
6. pH - pH of the discharge shall be within the range of 6.0 and 9.0.
7. There shall be no discharge of floating solids or visible foam in other than trace amounts.
8. In addition to the above requirements, the Montana Department of Health and Environmental Sciences may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharge through outfall 004 shall consist entirely of uncontaminated cooling water and shall not exceed 90°F.

The effluent limitations in the proposed permit are based on the proposed expanded mill production (1,850 tons per day).

PERTINENT MONTANA LAWS

Montana laws regarding water pollution control are contained in Sections 69-4801 through 69-4827, R.C.M. 1974. Particularly applicable sections are quoted below:

69-4802. Definitions. As used in this chapter, unless the context clearly indicates otherwise:

- (5) "Pollution" means such contamination or other alteration of the physical, chemical or biological properties, of any state waters, as exceeds that permitted by Montana water quality standards, including but not limited to standards relating to change in temperature, taste, color, turbidity, or odor, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any state waters as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, recreation, safety, or welfare, or to livestock, wild animals, birds, fish or other wildlife, provided, however, that any discharge which is permitted by Montana water quality standards is not "pollution" for the purposes of this chapter;

69-4806. Pollution unlawful--permits. It is unlawful to:

- (1) cause pollution as defined in section 69-4802 (5), R.C.M. 1974, of any state waters or to place or cause to be placed any wastes in a location where they are likely to cause pollution of any state waters;

- (2) carry on any of the following activities without a current permit from the department;
 - (a) construct, modify, or operate a disposal system which discharges to any state waters; or
 - (b) construct or use any outlet for the discharge of sewage, industrial wastes, or other wastes to any state waters; or
- (3) violate any limitation imposed by a current permit.

69-4808.2 Duties of board of health.

(1) The board shall:

- (a) review from time to time, at intervals of not more than three years, established classifications of waters and standards of water purity and classification, provided that
 - (3) the board shall require that any state waters whose existing quality is better than the established standards as of the date on which such standards become effective be maintained at that high quality unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of such waters, and
 - (4) the board shall require any industrial, public, or private project or development, which would constitute a new source of pollution or an increase source of pollution to high quality waters, referred to in (3) immediately above, to provide the degree of waste treatment necessary to maintain that existing high water quality;

MAJOR REQUIREMENTS OF THE EXISTING STATE WASTEWATER DISCHARGE PERMIT

- (a) This permit is for the discharge of the following wastewaters to the Clark Fork River:
 - (1) Uncontaminated cooling water at a maximum rate of 5.76 MGD as outlined in the department's letter to H-W Corporation dated August 17, 1966.
 - (2) Stored wastewaters (total volume of approximately 2,420 MG) during the spring runoff period with the flows in the Clark Fork River exceeding 10,000 cfs and in accordance with the constraints listed below:
 - a. Rate of wastewater discharge = $\text{TLM}_{96} \text{ of the wastewater (expressed as a decimal)} \times \text{River Flow} \times 0.02$
 - b. At no time shall the ratio of wastewater discharge to river flow exceed 1 part wastewater to 150 parts river flow.

- (3) Controlled seepage of the remainder of the wastewaters to provide at least 85% removal of 20° C BOD₅ of the wastewaters seeped to the river.
- (b) Identify and define the zone of complete mixing of the H-W spring wastewater discharge in the Clark Fork River by the expiration date of this permit.
- (c) Install sufficient treatment facilities to meet the effluent limitations listed below by July 15, 1975:
 - (1) 5.8 lbs. BOD₅ per ton of total mill product per year
 - (2) 5.6 lbs. TSS per ton of total mill product per year

The following implementation schedule will be followed to meet the above effluent limitations by July 15, 1975:

- (1) Submit preliminary engineering plans on the approach and design of aeration system by September 1, 1973.
 - (2) Submit final engineering plans by January 1, 1974.
 - (3) Submit construction schedule and begin construction by April 1, 1974.
 - (4) Complete the installation and start up by May 1, 1975.
- (d) Achieve compliance with the color and phenol criteria of the Montana Water Quality Standards by March 1, 1974.

Provide the Department of Health and Environmental Sciences with a plan of implementation by July 1, 1974, for meeting the above compliance date. The plan should specify dates for accomplishing the following intermediate steps:

- (1) Submit preliminary engineering design.
- (2) Submit final engineering design.
- (3) Submit final plans and specifications.
- (4) Submit construction schedule and begin construction.
- (5) Complete construction and start up.

In addition to the above conditions, the permittee is required to conduct a considerable amount of effluent and water quality monitoring as a condition of the permit.

With regard to the compliance schedule established by SDHES for H-W to meet the color standards established, recent H-W correspondence says:

Meeting the 5 color unit standard with rapid infiltration is a feasible approach on the basis of color data developed in the river during the summer of 1973. Figure 1 shows that the river color only exceeded the 5 color units during a short period in the middle of August. The river flows during this period were in the range of 1200 to 1400 cfs. Since the Clark Fork River was the lowest that anyone could ever remember, we decided to verify the 10-year, 7-day low flow of 830 cfs as reported by the U.S.G.S.

Figure 2 shows the 7-day low flows for the period from 1930 through 1972. Since the 7-day low flows increased significantly in the early forties and remained stable for the past 30 years, H-W made a request to use the last 30 years of data for determining the 10-year, 7-day low flows. However, this request was denied.

We have plotted the 7-day low flows for the period from 1930 through 1972 on probability paper (Figure 3) and found the 90% probability level corresponds to a 10-year, 7-day low flow of 930 cfs. The 7-day low flow for 1973 should raise the 930 cfs figures a little more, and this will be recalculated as soon as the data becomes available.

Assuming that the rate of percolation from our ponds during August, 1973 was equivalent to two-thirds of our present effluent flow, the total amount of color leaving the ponds was equal to:

$$15.8 \times 10^6 \text{ gal/day} \times \frac{2}{3} \times 3000 \text{ mg/color/liter} \times 3.785 \text{ liter/gal} \\ \times \frac{\text{gm}}{10^3 \text{ mg}} \times \frac{\text{lb}}{454 \text{ gm}} = 2.64 \times 10^5 \text{ lbs color/day}$$

The 2.64×10^5 lbs color/day is not representative of the color reaching the river, because we have measured a reduction of approximately 40% by the time it reaches our test wells, which are located between the ponds and the river.

Using the data from the summer of 1973, the amount of color required to raise the river color by 6 S.C.U. at a flow of 1200 cfs is calculated as follows:

$$1200 \text{ ft}^3/\text{sec} \times 60 \text{ sec/min} \times 1440 \text{ min/day} \times 7.48 \text{ gal/ft}^3 \times 6 \text{ mg/liter} \\ \times 8.34 \times 10^{-6} \text{ lb-liter/mg-gal} = 39,000 \text{ lbs color/day}$$

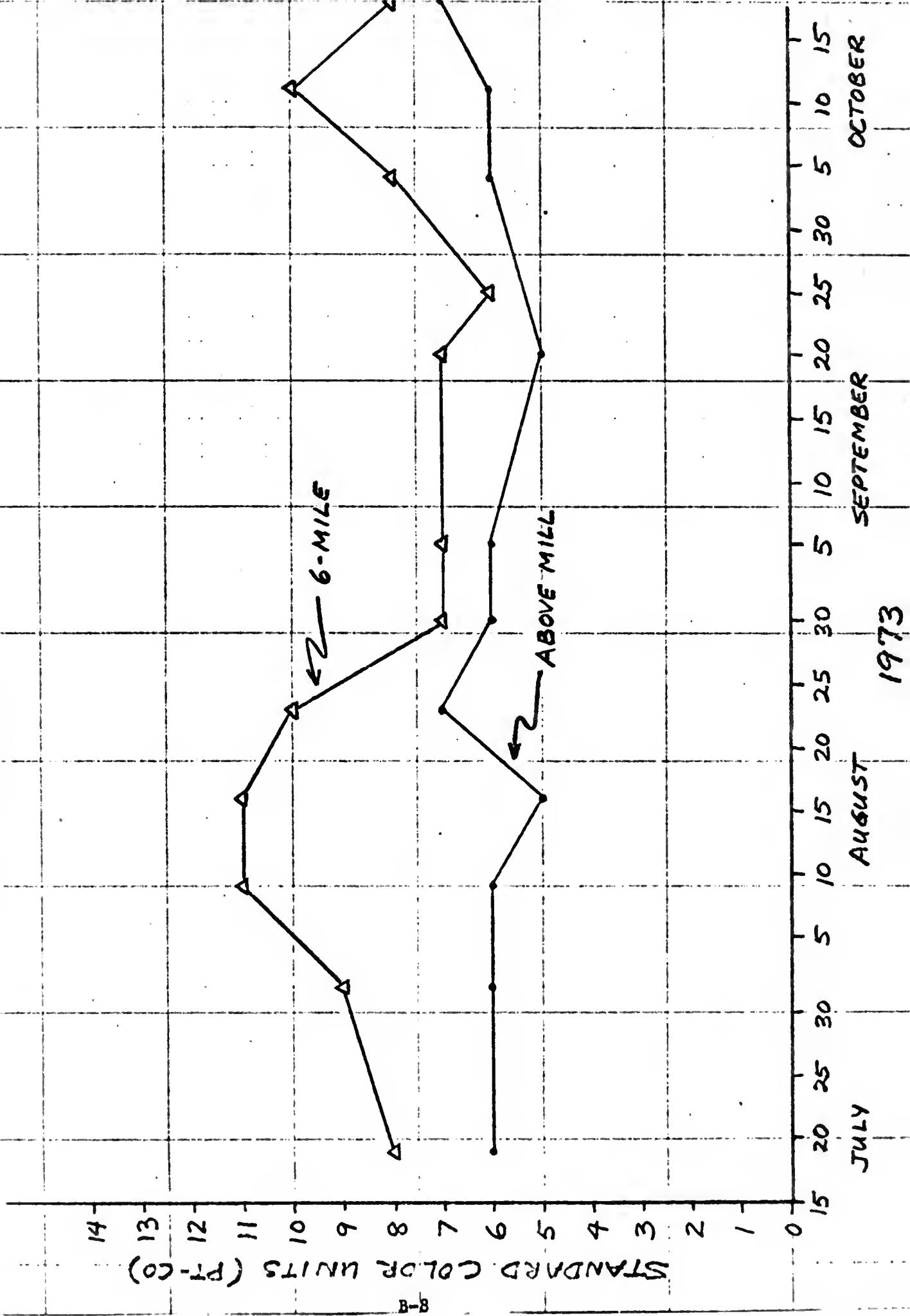
Therefore, the measured color in the river only represents about 15% of the calculated color leaving the storage ponds.

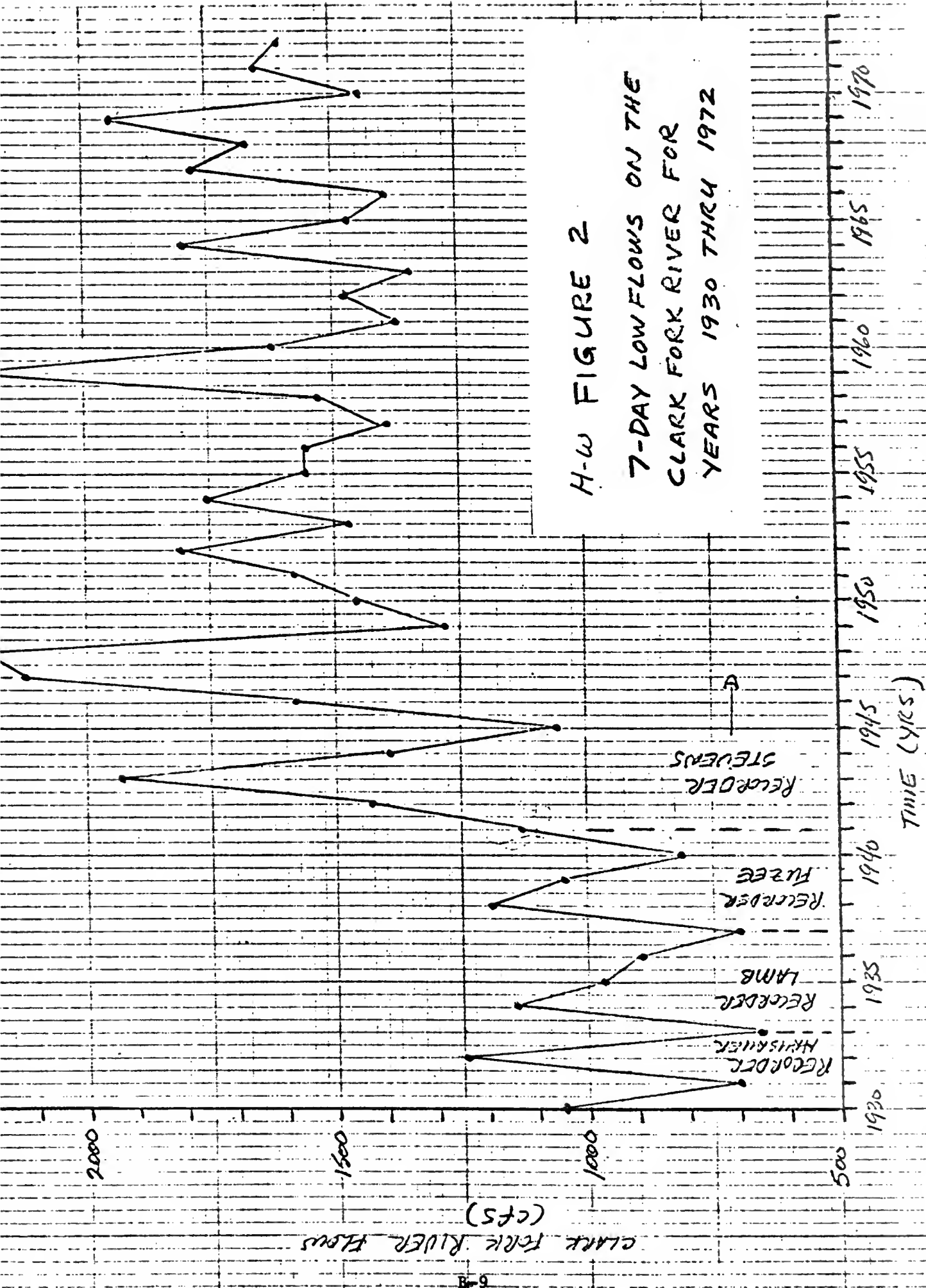
Under MPDES regulations (MAC 16-2.14(10)-S14460), Section (2), the minimum effluent standards are the same as those adopted by EPA.

EPA REFUSE ACT PERMIT PROGRAM

In June, 1972, effluent limitation guidance for the Refuse Act permit program was issued by EPA, which was in effect before passage of Public Law 92-500. The Montana Department of Health and Environmental Sciences used the values outlined by EPA in the compliance schedule for H-W, and these were concurred on by the Board of Health in September, 1972. The effluent limitations and compliance schedule adopted for BOD and TSS are as outlined in the state water discharge permit shown above.

H-W FIGURE 1

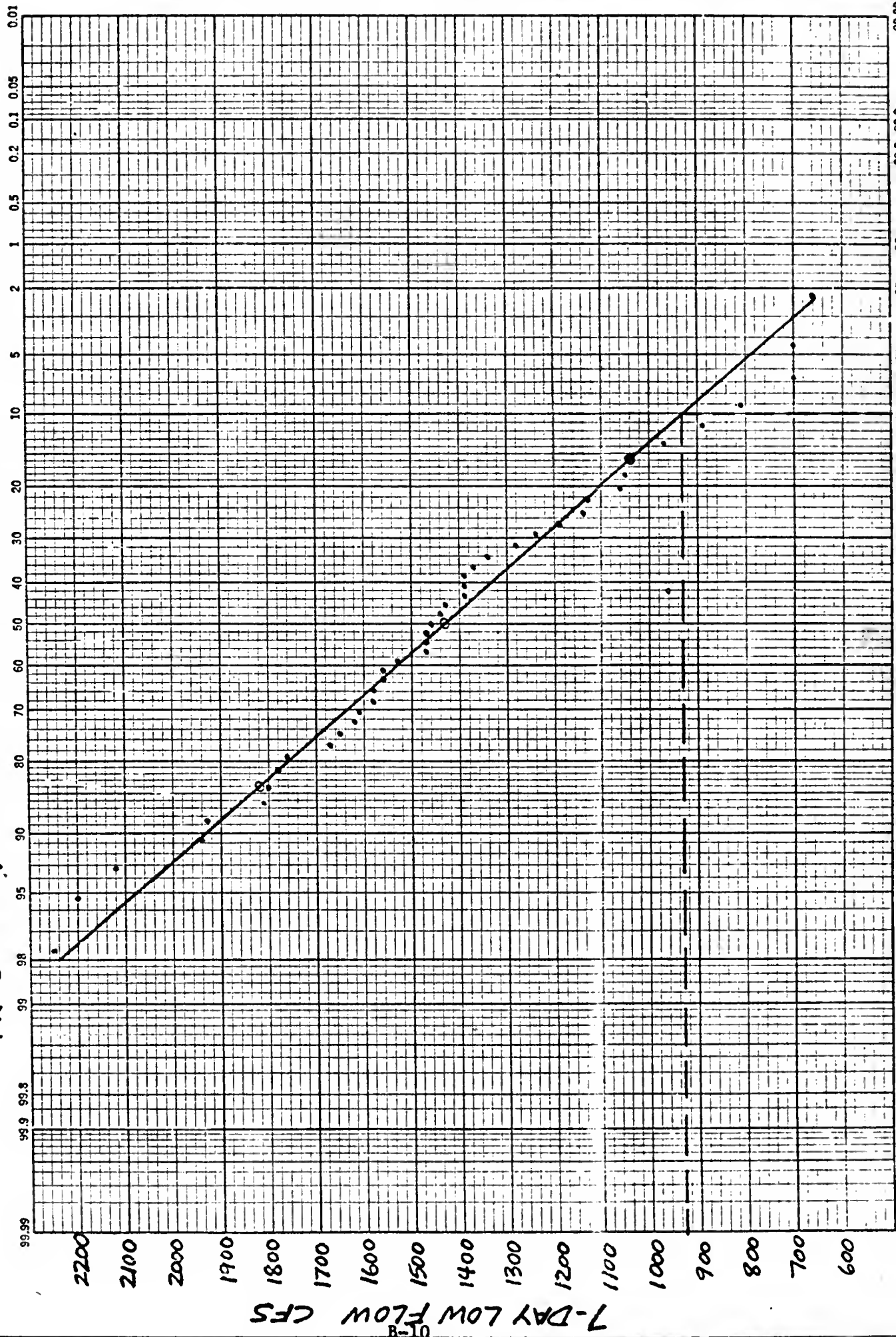




H-W FIGURE 2
7-DAY LOW FLOWS ON THE
CLARK FORK RIVER FOR
YEARS 1930 THRU 1972

H-W FIGURE 3

PROBABILITY PLOT OF 7-DAY LOW FLOWS - 1930 THRU 1972



This differs slightly from the best practicable treatment guidelines that are presently proposed by EPA, and H-W will need to meet the new minimum standards for BOD and suspended solids by the end of the compliance schedule previously established by the Department of Health and Environmental Sciences.

STATE WATER QUALITY STANDARDS

The Montana water quality standards are set forth in MAC 16-2.14(10)-S14480. The Clark Fork River is classified as B-D₁ and the most applicable standards sections for this classification are quoted below:

(d) B-D₁ classification

- (i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
- (ii) Specific water quality criteria
 - (aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.
 - (ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.
 - (ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained about 7.0
 - (ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.
 - (ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

- (af) No increases above naturally occurring concentration of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.
- (ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; no increase of more than 10 percent of the concentration present in the receiving water is permitted; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.
- (ah) True color is not to be increased more than five units above naturally occurring color.

(6) General water quality criteria

- (a) The degree of waste treatment required to restore and maintain the standards is to be determined by the department and is to be based on the following.
 - (i) The state's policy of nondegradation of existing high water quality as described in Section 69-4808.2 R.C.M. 1947.
 - (ii) Present and anticipated beneficial uses of the receiving water.
 - (iii) The quality and nature of flow of the receiving water.
 - (iv) The quantity and quality of the sewage, industrial waste or other waste to be treated.
 - (v) The presence or absence of other sources of pollution on the same watershed.
- (b) Sewage is to receive a minimum of secondary treatment as defined by EPA in accordance with requirements set forth in the Federal Water Pollution Control Act Amendments of 1972.
- (c) Industrial waste is to receive, after maximum practicable in-plant control, a minimum of secondary treatment or equivalent (reduction of suspended solids and organic materials where present in significant quantities, effective disinfection where bacterial organisms of public health concern are present, and control of toxic or other deleterious substances) before discharge into state waters.
- (d) For design of disposal systems, stream flow dilution requirements are to be based on minimum consecutive seven-day average flow which may be expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

- (e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:
- (i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
 - (ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.
 - (iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.
 - (iv) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.
 - (v) Create conditions which produce undesirable aquatic life.
- (1) Existing discharges to state waters will be entitled a mixing zone as determined by the department.
- (r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.
- (s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.
- When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Administration (1968), or by using other methods accepted as equal or applicable by EPA.
- (t) Metal limits for Clark Fork River (mainstem) from the confluence of Cottonwood Creek to the Idaho state line are:

<u>Material</u>	<u>Average Daily Concentration ug/l</u>	<u>Maximum Instantaneous Concentration ug/l</u>
Total copper	50	90
Dissolved copper	30	30
Total zinc	100	200
Total iron	300	1,300
Dissolved iron	150	150
Total lead	50	50
Dissolved lead	50	50
Total cadmium	10	10
Total arsenic	10	10
Total mercury	1	1

Regarding the underlined sentence in the preceding Section (5)(d)(11)(ag), the legal procedure for having this sentence deleted has been started. It was inadvertently carried from the A-open-D₁ classification to the B-D₁ classification when the standards were last revised. It puts many of the existing cities and industries in immediate violation and compliance would work unwarranted hardships in most cases.

Following stream survey work during the last year, an additional compliance schedule was established by the department this year for H-W. The additional compliance schedule pertains to the parameters of color and phenols. See the above summary of the conditions of this year's state waste discharge permit for the aforementioned compliance schedules.

It is not known if there is a violation of the phenol standard at this time. Phenol was put in the compliance plan in response to some of the University of Montana personnel who thought it was important and that the standards would be violated.

Technically, for the H-W mill expansion, the non-degradation requirements set forth in Section 69-4808.2(1)(c)(3) and (4) are interpreted as being met as long as there is no increase in the amount of pollutants in the total loading from the existing mill (prior to installation of the aerated lagoon system). However, it should be noted that H-W is not presently providing adequate effluent treatment and therefore was given a compliance schedule by the Board of Health to provide a minimum of secondary treatment by July 15, 1975. Based on the previous discussion, it is felt that the aforementioned non-degradation requirements will be met as long as the effluent produced by the expanded mill meets the BPT performance standards for the mill based on production prior to expansion. It should be noted that estimates indicate the mere installation of the biological treatment system (independent of the mill expansion) may increase the amount of phosphorus contained in the H-W discharge over the amount presently contained. It is estimated that the amount of nitrogen in the discharge will decrease after the addition of the biological treatment system.

In summary, the installation of the biological treatment system may increase the phosphorus load to the receiving waters, but at the same time it will reduce the toxicity of the discharge, reduce the BOD and nitrogen load on the receiving waters, eliminate most of the odors associated with the present effluent ponding system, significantly reduce the amount of phenols in the discharge, and substantially reduce the taste and odor causing properties of the discharge. As discussed previously, the increased phosphorus discharge is rather minor and will not create eutrophication problems in the Clark Fork River.

Montana, like almost all the other states, has not established groundwater standards. Work has begun on developing a proposed regulation, but adoption of such a regulation is not expected for at least a year.

A P P E N D I X C

QUALITY CONTROL OF GAS CHROMATOGRAPH MONITORING

Department of Health and Environmental Sciences

STATE OF MONTANA, HELENA, MONTANA 59601

John S. Anderson M.D.
DIRECTOR

December 19, 1973

Mr. Roy Countryman, Manager
Hoerner-Waldorf Corporation
Missoula, MT 59801

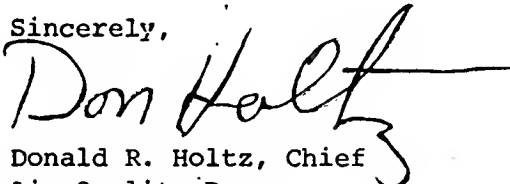
Dear Mr. Countryman:

We are enclosing what we consider essential to a study and quality control program for the ambient sampling around the Hoerner-Waldorf pulp mill. An environmental study must be based on reliable data which is comprehensive enough to be credible. The quality of any environmental impact statement will be largely dependent on the time allowed for the study and the professional competence of the personnel who participate.

Regarding the routing of the gas chromatograph strip charts, we think that for several reasons, including anticipated and already voiced criticism of the sampling program, it is of utmost importance that the charts be read and evaluated by the Department of Health and Environmental Sciences personnel before the charts are shipped out of the state to the contractor.

The Department of Health and Environmental Sciences must have discretion as to the adequacy and reliability of data and information furnished by the applicant. It is important, therefore, that we begin the complete collection of this data now so that we can verify your sampling results as the study proceeds and be able to make our decision on a construction permit as soon as is possible.

Sincerely,



Donald R. Holtz, Chief
Air Quality Bureau

DRH:ADM:dmg
Enclosures

cc: Dr. John S. Anderson
Steve Brown
Roland Samel

1. Tracor Gas Chromatographs

1. Calibration

Once each two weeks a multipoint calibration is to be performed on each machine; that is, with given permeation tubes (they may be combined) the flow rates are changed such that different concentrations are obtained to plot calibration curves and to check for linearity. If there are questions as to which peaks correspond to given parameters, it may be necessary to run individual retention time relationships on permeation tubes on an independent basis. All instrument settings, flow rates, temperatures, calibration curves, copy of sections of chart paper including the calibrations, and so forth are to be recorded and/or pasted into the log book. More detail about log book notation is submitted below. Calibration of flow rates must also be made during this general calibration.

2. Permeation Tubes

Since two columns are involved (a. special silica gel; b. teflon column packed with teflon and coated with polyphenyl ether) the following certified and/or calibrated permeation tubes are required: sulfur dioxide, hydrogen sulfide, methyl mercaptan, ethyl mercaptan, propyl mercaptan, carbonyl sulfide, dimethyl sulfide. For permeation tubes, date received, nominal shelf life at a given temperature, tube length and permeation rate in nanograms/min per cm. of tube length at given temperatures must be stated in the log books. Zero air or suitable air scrubbers must be used during calibration for the air which passes over the permeation tubes.

3. Columns

a. Tracor silica gel columns are used both for the scrubber and analytical columns. Moisture, dirt or other causes may deteriorate one or either of the above columns. Such deterioration of columns is evidenced by peak broadening and distortions along with possible changes in peak retention time. Even with backflushing of the scrubber column, the above may occur. It is, therefore, necessary to have additional columns readily available or on hand.

b. Teflon columns (packed with teflon and coated with polyphenyl ether) on scrubber and analytical segments are also influenced by the above discussion. This column will not be routinely used--it will be installed on each analyzer (both on scrubber and analytical column) at least six hours per month and at times when significant readings are evidenced by the silica gel column. Each cycle should run at least 10 minutes.

4. Log Books

Daily entries into the log books need to be made for the following: pressure or flow rates for both hydrogen supplies; carrier gas and sample; regulator settings for cylinders; sample loop size; description of column being used; temperature readings for detector and column; trailer or room temperature; can sulfur odor be detected outside the enclosure?; estimated wind speed and direction; chart recorder speed and millivolt setting; any visitors to trailer logged in (visitors are any persons other than the operator). Log books are to be retained with each chromatograph. Daily record sheets are sufficient for the bubblers, hi-vol samplers and wind machines.

5. Trailer or Building

Temperature within building or trailer must be held constant. Also access to the enclosure must be limited to authorized personnel (all excepting operator must sign in along with date and time). All doors must be left locked when no one is attending monitoring equipment.

6. Data

Original charts from the chart recorders will be forwarded directly upon removal from the recorder and before they leave the state via certified mail to the Air Quality Bureau either weekly or as each chart roll is changed. This chart will be read and forwarded to the contractor in Florida. A copy of all calibration data essential for reading the chart must accompany the chart recording. A copy of the log book record for the last calibration should suffice for this requirement. The contractor or the company must have available the chart recordings which leave the state for future reference.

On the chart recording will be recorded with each servicing or daily check rotometer, pressure gauge and column and detector temperatures, date, time (draw line to exact time), zero or baseline reading (draw an arrow to this baseline reading), attenuation where it applies, whether can smell sulfur compound outside, estimated wind speed and direction, malfunctions, operator signature and specific column in use.

II. Wind Systems

Instruments need to be calibrated monthly for direction and temperature (where applicable). Daily sheets will be filled out at least five days a week. Enclosed is a copy of the necessary daily record sheet. Chart recordings from the Hill station and daily sheets for both weather systems will be mailed along with the chart recordings to the Air Quality Bureau on a weekly or monthly basis. The Bureau will reduce the Hill data with Environmental Science and Engineering doing the Frenchtown station. This latter reduced to sixteen points wind data will be forwarded to us as it is available.

III. Bubblers

Integrated gas bubblers will be maintained at the Hill site for sulfur dioxide, ~~and hydrogen sulfide~~. Calibration of the limiting orifices will be performed monthly with the flow rates being recorded in a log book. Impingers must be identified and correlated to the limiting orifice; color coding works best for this.

The Reference method (Appendix A, Fed. Reg. 36, No. 84, Part II) for sulfur dioxide is enclosed for your information and must be followed as to sample handling and storage, chemical analysis, calculations, etc. ~~The method for the hydrogen sulfide bubblers is the tentative method as given in the book Methods of Air Sampling and Analysis, an Interscience Committee publication, 1972 edition.~~

Precaution must be made to insure that the impingers are heated, that timers record correct total times, the teflon tubing is used as an inlet to impingers, and that correct flow rates are maintained.

The Air Quality Bureau requires samples be split on a random sampling basis as indicated on the enclosed sheet which lists Month, Date and Day. Sulfur dioxide samples will be sent to the Air Quality Bureau in Helena. ~~and hydrogen sulfide samples will be given to Roland Samel in Missoula for chemical analysis.~~

IV.

Hi-vol samplers will be operated as indicated in the enclosed Federal Register. The necessary hi-vol calibrations need to be performed once each two months. Use of the enclosed calibration form is encouraged. Hi-vol samples will be operated at all three sites for 24-hour sampling periods. Filters must be pre-equilibrated 24-hours both before original and final weighings in a relative humidity range not to exceed 40% nor below 20%.

Each hi-vol filter must be accompanied by documentation as to weather conditions, winds, visifloat readings, etc. (See enclosed sheet). Each filter must be serialized and used only if it is intact; i.e., without tear or fold before the field run.

V.

The Bureau may request the monitor enclosed within the trailer, the wind system and the hi-vol sampler be moved to some other site during the time of the study.

A P P E N D I X D

DIFFUSION MODEL FOR HOERNER-WALDORF H_2S

DIFFUSION MODEL FOR HOERNER WALDORF H₂S

POND EMISSIONS

The H₂S emissions from the pond were assumed to result from an area source. When working with an area source an imaginary point source is selected from which the emissions are theorized to originate. The selection of the theoretical point source is achieved by assuming a horizontal standard deviation of σ_{y0} at the pond location. From Turner (1969) $\sigma_{y0} = S/14.3$ where S is the distance of a side of a square area source. If the area of the pond were assumed to be a square of 20 acres (871,200 ft²), a side dimension would be 933 feet. Therefore,

$$\sigma_{y0} = 933 \text{ ft}/4.3 = 217 \text{ ft.} = 66.2 \text{ m}$$

For a given Pasquill category $\sigma_{y0} = aXy^b$ where a and b are constants. The constants a and b and the virtual distance Xy are given for the six Pasquill categories in Table . For each category the location of the theoretical point source varies.

Pasquill Category	Table				Virtual Distance (Xy) Km	Ambient H ₂ S Concentration over ponds PPB
	a	c	b	d		
A	.20	.45	.88	.20	.28	106
B	.16	.11	.88	.16	.37	87
C	.10	.001	.88	.10	.63	81
D	.07	.033	.88	.07	.94	102
E	.052	.023	.88	.052	1.32	122
F	.035	.015	.88	.035	2.06	157

Once the virtual distances (Xy) have been calculated the dispersion model can be applied. The equation used to estimate ambient levels was taken from Turner (1969). The equation (Eqn 3.4 of Turner) for a ground level source with no effective plume is stated below.

$$X = \frac{Q}{\pi \sigma_y \sigma_z u}$$

Equ. 3.4 of Turner

X = ambient ground level concentration in g/m³

Q = H₂S emission rate from ponds = 4.2 g/sec

σ_y = horizontal standard deviation of plume in meters $\sigma_y = ax^b$

σ_z = vertical standard deviation of plume in meters $\sigma_z = cx^d$

u = wind speed = 3.57 meters/second

The ambient estimates have units of g/m³ for 10 minute periods.

These values were converted to one-half hour averages with units of parts per billion (PPB). The conversion is shown below:

$$X\left(\frac{g}{m^3}\right) = X\left(\frac{g}{m^3}\right) \left(\frac{1000000 \text{ ug}}{g} \right) \times \left(\frac{1.000 \text{ PPB}}{1.4 \text{ ug/m}^3} \right)$$

$$X \left(\frac{10 \text{ min}}{30 \text{ min}} \right) .2 = X \frac{g}{m^3} \times \frac{573,000 \text{ PPB } m^3}{g}$$

$$= X \text{ (PPB)}$$

Ambient levels were estimated for six Pasquill categories at 3 kilometer intervals from the ponds. Results of these estimates are shown in Table

Table

Ground Level H₂S Estimates from Hoerner-Waldorf Ponds
(proposed 1974)

Units are in Parts per Billion H₂S for ½ Hour

Distance Downwind (Km)	Pasquill Category					
	A	B	C	D	E	F
3	.07	1.1	3.5	12	24	47
6	.01	.31	1.2	5.3	11	26
9	--*	.15	.60	3.1	7.0	17
12	--*	.084	.37	2.1	4.9	12
15	--*	.005	.25	1.5	3.7	9.4
18	--*	.038	.18	1.2	2.9	7.6
21	--*	.028	.14	.96	2.4	6.3

*Less than .01 ppb

The short term dispersion model was also utilized to estimate ground level concentrations from the H-W stacks. A different version of the model as outlined in Turner (Eq. 3.1) was utilized for stack emissions. This equation is given below:

$$\text{Turner Equ. 3.3} \quad X = \frac{Q}{\pi \sigma_y \sigma_z u} \left[\exp -\frac{1}{2} \left(\frac{1+y}{P_2} \right)^2 \right]$$

The stack parameters were averaged by weighted methods. Such assumptions provide that all emissions come from a single stack. The theoretical stack parameter are listed below:

H - effective stack height = 170 m

Q - emission rate = 2.7 g/sec

u - wind speed = 3.57 m/sec

y - horizontal deviation from plume centerline = 0 m

σ_y - horizontal standard deviation $\sigma_y = ax^b$

σ_z - vertical standard deviation $\sigma_z = cx^d$

Results of the model are listed in Table . This results assume flat terrain and would result at points parallel to the axis of the valley bottom.

Table
Ground Level H₂S Estimate from Hoerner-Waldorf Stacks
(proposed 1974)
Units are in Parts per Billion H₂S for ½ Hour

Distance Downwind (Km)	Pasquill Category					
	A	B	C	D	E	F
3	.06	.80	1.9	.34	--*	--*
6	--*	.22	.78	.90	.12	--*
9	--*	.10	.41	.90	.30	--*
12	--*	.06	.25	.77	.42	.01
15	--*	.04	.17	.65	.48	.03
18	--*	.03	.12	.55	.50	.05
21	--*	.02	.09	.47	.49	.07
						**

*Less than .01 ppb

**For category F a maximum of .23 ppb would theoretically result at approximately 70 Km downwind.

If elevation were incorporated into the dispersion model for plant emissions the maximum concentration would result at an elevation equivalent to the effective plume rise (170 meters above stack base). The nearest point with such an elevation in the vicinity of the H-W facilities would be approximately 2.1 Km to the southwest. Under extremely stable conditions with light winds impacting the plume on the mountainside, a concentration of 49 PPB would theoretically result. Such a result could be obtained from the following equation:

Equ. 3.1 of Turner

$$X = \frac{Q}{2\pi\sigma_y\sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \left\{ \exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right] \right\}$$

All stack parameters would be the same as noted above with the additional parameter "z" (difference in elevation from plant base) = 170 meters. Again the concentration with units of g/m³ would be converted to PPB by multiplying by $573,000 \frac{\text{PPB} \cdot \text{m}^3}{\text{g}}$

BACKGROUND AND EDUCATION OF PERSONS PREPARING THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED EXPANSION OF HOERNER-WAEDORF'S MILL

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Daniel Vichorek, B.A., Journalism, University of Montana, 1969; experience as a general assignment and police reporter for the Billings (Montana) Gazette and the City News Bureau of Chicago; 16 month's experience as a Technical Writer for the Environmental Sciences Division.

Don Willems, Chief, Water Quality Bureau, B.S., Sanitary Engineering, University of Illinois, 1951; M.S., Civil Engineering, University of Florida, 1959; registered professional engineer, Montana; Technical Service Engineer on water and wastewater equipment, Infilco, Inc., Tucson, Arizona, 1951-56; experience in water pollution control with the State Department of Health and Environmental Sciences, 1956-58, 1959 to present.

James Brown, B.S., Civil Engineering, South Dakota School of Mines and Technology, 1970; M.S., Environmental Health Engineering, University of Texas at Austin, 1973; Public Health Engineer, South Dakota Department of Health, 1970-72; Public Health Engineer, State Department of Health and Environmental Sciences, September, 1973 to present.

Abe Horpestad, B.S., Botany, Montana State University, 1966; M.S., Botany, Montana State University, 1969; three years' experience as a water quality research assistant, Montana State University; two years' experience as Consulting Ecologist, Union Carbide Corporation, Instructor, University of California, Riverside; aquatic ecology; limnological consultant for the Water Quality Bureau, September, 1973 to present.

Maxwell K. Botz, B.S., Geological Engineering, University of Nevada, 1957; M.S., Geological Engineering, University of California, Berkeley, 1962; registered professional engineer, Colorado and Montana; three years' experience as an agricultural engineer; three years' experience as a geological engineer; Chief Hydrologist and Associate Professor of Geology, Montana Bureau of Mines and Geology and Montana College of Mineral Science and Technology, 1965-1970; hydrogeologist and consulting engineer, 1970-72; Water Quality Engineer for the Water Quality Bureau, 1972 to present.

Jon Bolstad, B.S., Chemical Engineering, 1971, Montana State University; Approximately three years' experience in air pollution control with the Air Quality Bureau.

